C Programming Language Course
Lesson 1: Data & Information

Topics

1. Introduction
2. Numeral systems
3. Units of Information
4. Final Considerations

Course Program

- Concept of Data and Information;
- Structure of a program. Exercises;
- Types of Data (Characters, Integers, Float Numbers);
- Variables and Modifiers;
- Data Input and Output;
- Operators;
- Sequencing;
- Conditional statements;
- Loops;
- Arrays (Vectors and Matrices);
- Pointers;
- Dynamic memory allocation;
- Functions.

Data & Information

Data VS Information

Data: atribute or **part** of **information**.
Information: set of **structured data** with meaning.

Knowledge VS Wisdom

Knowledge: Knowing **true information**.
Wisdom: quality of having experience to apply the knowledge for **good decisions**; quality of being **wise**.

Numeral systems

The **information** can be codified into **numbers** of different **systems**:

- **Decimal**: **10** digits: $\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$;
- **Binary**: **2** digits: $\{0, 1\}$;
- **Octal**: **8** digits: $\{0, 1, 2, 3, 4, 5, 6, 7\}$;
- **Hexadecimal**: **16** digits: $\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9,$ **A**, **B**, **C**, **D**, **E**, **F**$\}$. The letters from **A** to **F** represent the numbers from 10 to 15.

Examples of Numbers

- **Decimals**: $2021_{(\mathbf{10})}$, $10_{(\mathbf{10})}$, $20_{(\mathbf{10})}$, etc.
- **Binaries**: $0_{(\mathbf{2})}$, $1_{(\mathbf{2})}$, $101_{(\mathbf{2})}$, $0101_{(\mathbf{2})}$, etc.
- **Octals**: $2021_{(\mathbf{8})}$, $10_{(\mathbf{8})}$, $20_{(\mathbf{8})}$, etc.
- **Hexadecimals**: $2d1_{(\mathbf{16})}$, $10_{(\mathbf{16})}$, $20f_{(\mathbf{16})}$, etc.
- **Online calculator**: https://www.rapidtables.com/convert/number/hex-to-decimal.html
- **ASCII Table**: https://web.fe.up.pt/ ee96100/projecto/Tabela

Note: ASCII - *American Standard Code for Information Interchange.*

Conversion From Decimal to Other Systems

Calculation performed using the sequence of remainders from **integer divisions** by the **base** (**2**, **8** ou **16**), ordered from the last to the first:

To Binary:

- $20_{(\mathbf{10})} \rightarrow 20/2 = 10(\mathbf{0}) \rightarrow 10/2 = 5(\mathbf{0}) \rightarrow 5/2 = 2(\mathbf{1}) \rightarrow 2/2 = 1(\mathbf{0}) \rightarrow 1/2 = 0(\mathbf{1})$. Therefore $20_{(\mathbf{10})} = 10100_{(\mathbf{2})}$

To Octal:

- $100_{(\mathbf{10})} \rightarrow 100/8 = 12(\mathbf{4}) \rightarrow 12/8 = 1(\mathbf{4}) \rightarrow 1/8 = 0(\mathbf{1})$. Therefore $100_{(\mathbf{10})} = 144_{(\mathbf{8})}$

To Hexadecimal:

- $100_{(\mathbf{10})} \rightarrow 100/16 = 6(\mathbf{4}) \rightarrow 6/16 = 0(\mathbf{6})$. Therefore $100_{(\mathbf{10})} = 64_{(\mathbf{16})}$

Conversion to Decimal

Binaries:

- $101_{(2)} = 1 \times \mathbf{2}^2 + 0 \times \mathbf{2}^1 + 1 \times \mathbf{2}^0 = 5_{(\mathbf{10})}$
- $1011_{(2)} = 1 \times \mathbf{2}^3 + 0 \times \mathbf{2}^2 + 1 \times \mathbf{2}^1 + 1 \times \mathbf{2}^0 = 11_{(\mathbf{10})}$
- $11111_{(2)} = 1 \times \mathbf{2}^4 + 1 \times \mathbf{2}^3 + 1 \times \mathbf{2}^2 + 1 \times \mathbf{2}^1 + 1 \times \mathbf{2}^0 = 31_{(\mathbf{10})}$

Octals:

- $123_{(\mathbf{8})} = 1 \times \mathbf{8}^2 + 2 \times \mathbf{8}^1 + 3 \times \mathbf{8}^0 = 83_{(\mathbf{10})}$
- $137_{(\mathbf{8})} = 1 \times \mathbf{8}^2 + 3 \times \mathbf{8}^1 + 7 \times \mathbf{8}^0 = 95_{(\mathbf{10})}$
- $216_{(\mathbf{8})} = 2 \times \mathbf{8}^2 + 1 \times \mathbf{8}^1 + 6 \times \mathbf{8}^0 = 142_{(\mathbf{10})}$

Hexadecimals:

- $29_{(\mathbf{16})} = 2 \times \mathbf{16}^1 + 9 \times \mathbf{16}^0 = 41_{(\mathbf{10})}$
- $2f_{(\mathbf{16})} = 2 \times \mathbf{16}^1 + f \times \mathbf{16}^0 = 47_{(\mathbf{10})}$
- $24f_{(\mathbf{16})} = 2 \times \mathbf{16}^2 + 4 \times \mathbf{16}^1 + f \times \mathbf{16}^0 = 591_{(\mathbf{10})}$

The Binary Digit

- A **bit** is an acronym of **bi**nary digi**t**;
- With a **bit** we can encode **2** different information (**0** ou **1**);
- With two **bits** we can encode **4** different information (00, 11, 01, 10);
- With three **bits** we can encode **8** different information (000, 111, 001, 110, 011, 100, 010, 101);
- With four **bits** we can encode **16** different information (0000, 1111, 0001, 1110, etc.);
- In general we can encode 2^n different information with n **bits**;

Units of Information

A group of **8 bits** is called **Byte** ($2^8 = 256$ different information).
A *"half-byte"* is also called **Nibble** and a *"half-nibble"* is also called **Crumb**, but there are more:

- **Kilobyte (KB)** = 1024 **Bytes**;
- **Megabyte (MB)** = 1024 **Kilobytes**;
- **Gigabyte (GB)** = 1024 **Megabytes**;
- **Terabyte (TB)** = 1024 **Gigabytes**;
- **Petabyte (PB)** = 1024 **Terabytes**;
- **Hexabyte (HB)** = 1024 **Petabytes**;
- **Zettabyte (ZB)** = 1024 **Hexabytes**;
- **Yottabyte (YB)** = 1024 **Zettabytes**.

Thanks a lot! Follow us.