Components of a
Machine
And how it works

اَللّٰهُمَّ اُرْزُقْنِى عِلْمًا نَافِعًا وَّاسِعًا عَمِيْقًا

اَللّٰهُمَّ اُرْزُقْنِی رِزْقًا وَاسِعًا حَلَالًا طَیِّبًا مُبَارَكًا مِنْ عِنْدِكَ

Mr. Robo: Machine

Mr. Robo is a **Machine**. Mr. Robo can be given **instructions** to perform many tasks.

Mr. Robo: Machine

These are the possible words that Mr. Robo understands.

Instructions	
Action Code	
Move	0 0 0 1
Charge	0 1 0 0
Direction Code	
Left	0 0
Right	0 1
Up	1 0
Down	1 1
Step Code	
Zero Step	0 0 0
One Step	0 0 1
Two Step	0 1 0
Three Step	0 1 1

Mr. Robo: Operation Code

Mr. Robo understands only a predefined set of words.
These set of words are called Operation Codes.

Instructions	
Action Code	
Move	0 0 0 1
Charge	0 1 0 0
Direction Code	
Left	0 0
Right	0 1
Up	1 0
Down	1 1
Step Code	
Zero Step	0 0 0
One Step	0 0 1
Two Step	0 1 0
Three Step	0 1 1

Mr. Robo: **Instruction**

We combine these operation code to make a complete **Instruction**. For example,

<div align="center">

0001 **01** **001**

</div>

is a complete instruction that move Robo one step right.

Instructions	
Action Code	
Move	0 0 0 1
Charge	0 1 0 0
Direction Code	
Left	0 0
Right	0 1
Up	1 0
Down	1 1
Step Code	
Zero Step	0 0 0
One Step	0 0 1
Two Step	0 1 0
Three Step	0 1 1

Mr. Robo: **Instruction**

Mr. Robo only understands the **Instruction** when you give in the specific order.

Action Code	Direction Code	Step Code

Instructions

Action Code

Move	0 0 0 1
Charge	0 1 0 0

Direction Code

Left	0 0
Right	0 1
Up	1 0
Down	1 1

Step Code

Zero Step	0 0 0
One Step	0 0 1
Two Step	0 1 0
Three Step	0 1 1

Mr. Robo: Input

Mr. Robo takes these instructions as 0 or 1 through its tray. The tray is called Input Device.
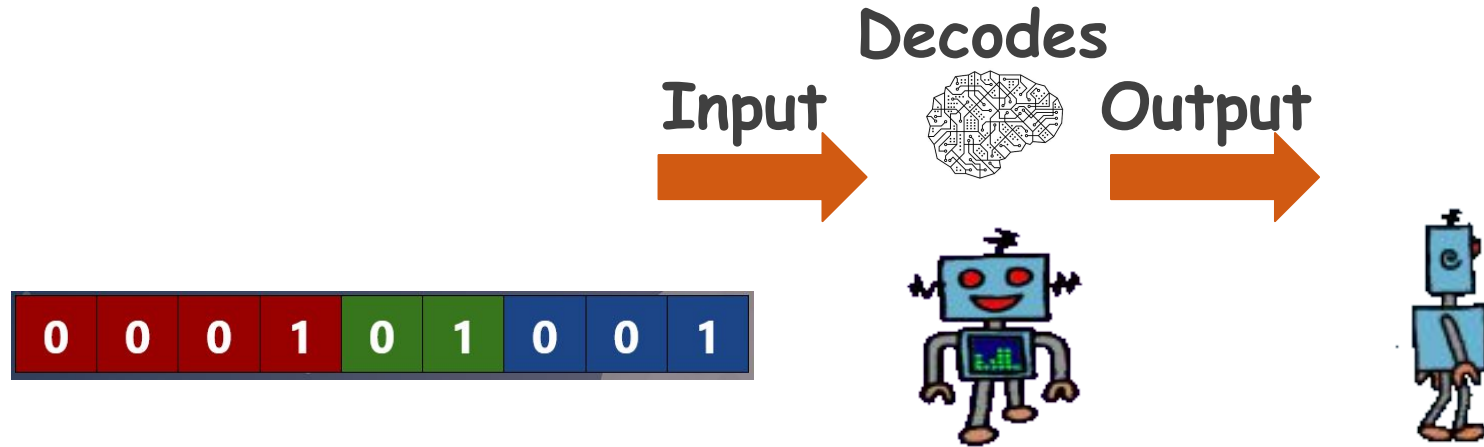
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |

Mr. Robo: CPU (Brain)

The Brain (Central Processing Unit) of Mr. Robo Decodes the instruction.
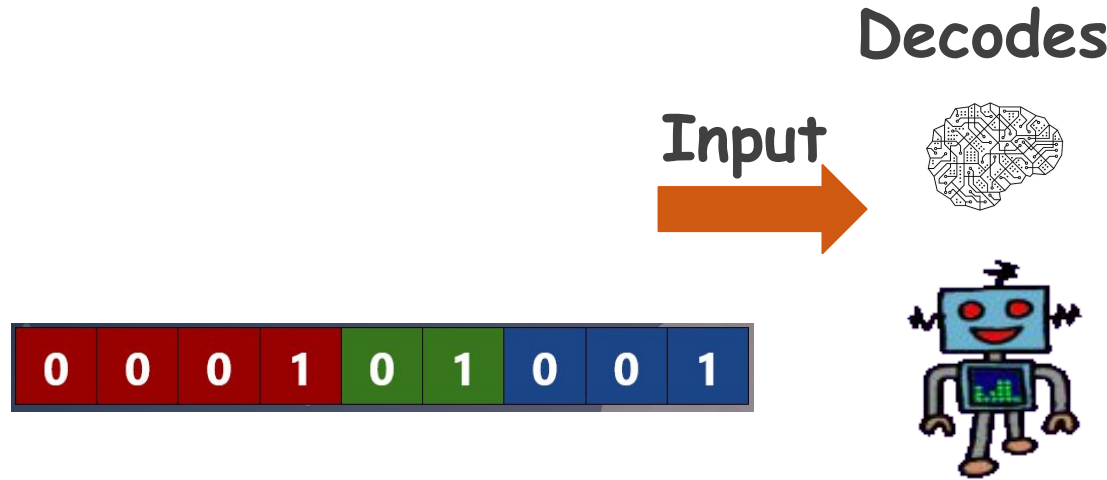
Mr. Robo: Instruction Cycle

In order to process the information, CPU (brain) first **fetches** the instruction, **decodes** it and then **executes** it to give output. This is called **Instruction Cycle.**

Decodes

Input

Output

| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |

Mr. Robo: Computation Step

One instruction is called one Computation Step because this is a unit task that CPU (Brain) can perform.

Decodes

Input

Output

| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
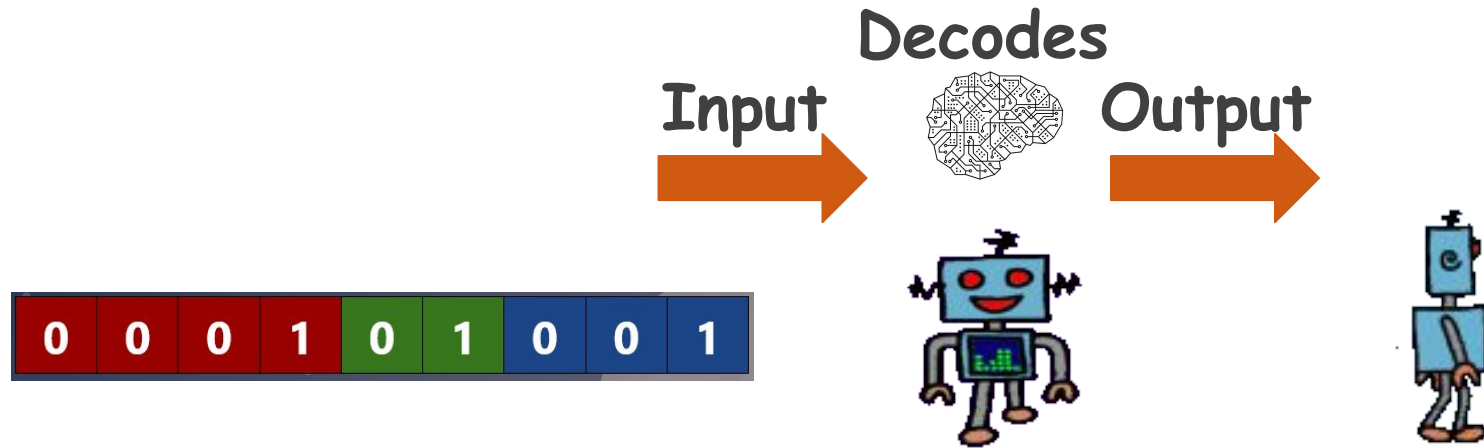
Mr. Robo: Why Understand 0 and 1?

Why Mr. Robo understands only 0 and 1?

Mr. Robo: Why Understand 0 and 1?

Because Mr. Robo is an **Electric Machine** that can understand 0 (no or low electricity in wires) and 1 (electricity or high electricity in wires) naturally.

Mr. Robo: Binary Language

Thus, Mr. Robo understands a language that has only two alphabets (0 and 1). This language is called Binary Language.

Mr. Robo: Machine Language

So, binary is the Mother Tongue or Natural Language of the Mr. Robo. Technically, it is also called Machine Language.

| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |

Mr. Robo: Binary Language

Why Binary? Why not any other language? Binary is so difficult for Us to Remember.

Mr. Robo: Input

Mr. Robo takes these instructions as **0** or **1** through its **tray**. The tray is called **Input Device**.
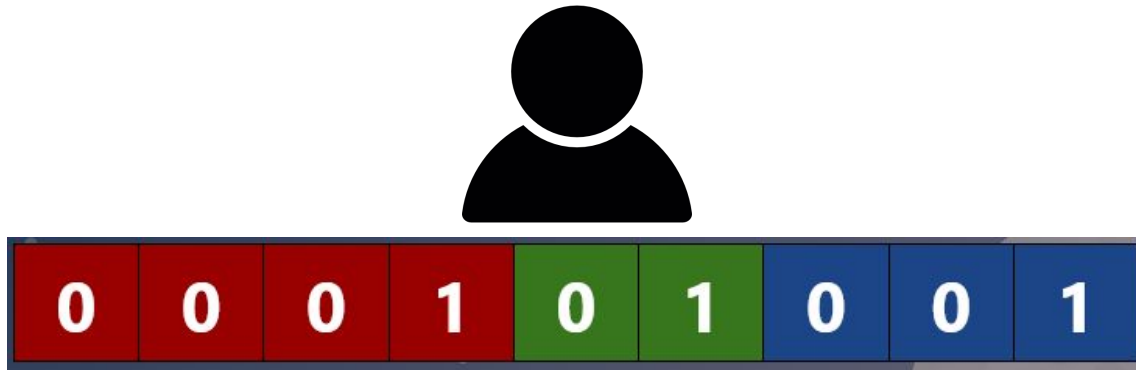
0	0	0	1	0	1	0	0	1

Instructions

Action Code

Move	0 0 0 1
Charge	0 1 0 0

Direction Code

Left	0 0
Right	0 1
Up	1 0
Down	1 1

Step Code

Zero Step	0 0 0
One Step	0 0 1
Two Step	0 1 0
Three Step	0 1 1

Mr. Robo: Binary Language

What if there is someone, who understands binary language and we tell him the instruction in **English** and he converts that into **Binary**.
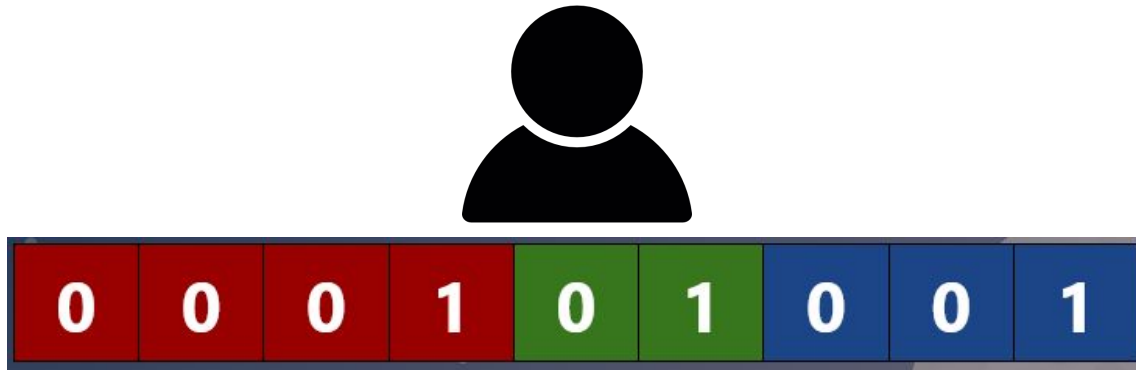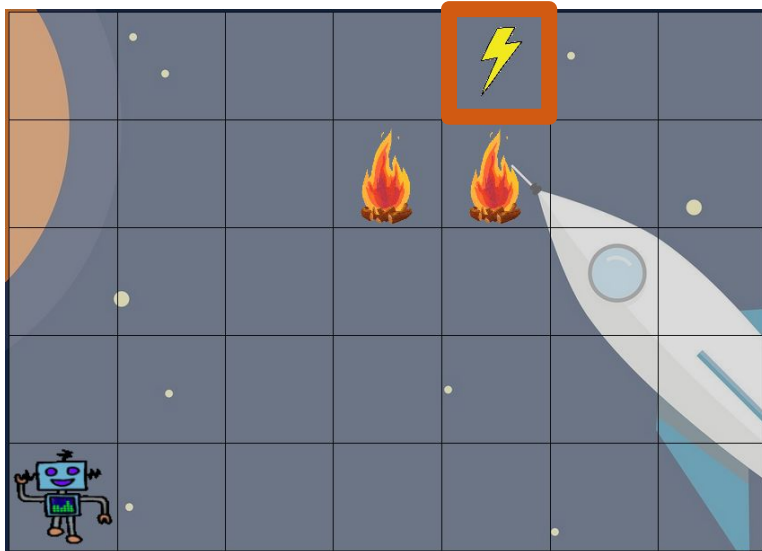
Move Right One Step

| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |

Mr. Robo: Compiler

Such translator is called Compiler.

Move Right One Step
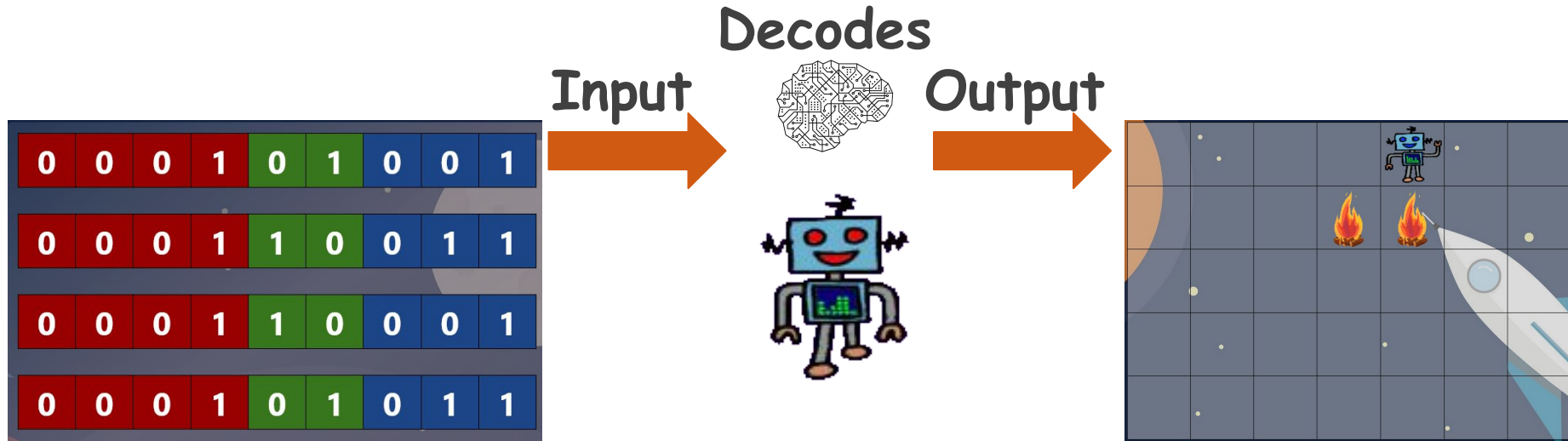
| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |

Mr. Robo: How to move?

We need Mr. Robo to go to Charge location with these available Operation Codes. **What do we do?**

Instructions

Action Code

Move	0 0 0 1
Charge	0 1 0 0

Direction Code

Left	0 0
Right	0 1
Up	1 0
Down	1 1

Step Code

|	
Zero Step	0 0 0
One Step	0 0 1
Two Step	0 1 0
Three Step	0 1 1

Mr. Robo: Multiple Computation Steps

If we need Mr. Robo to move at some location for that we do not have single instruction, we need to instruct in terms of **Multiple Computation Steps**.

Decodes

Input

Output

| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |

| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |

| 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |

| 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |

Mr. Robo: After 1st Instruction

These set of Instructions are executed by brain (CPU) one by one in the given sequence.

Decodes

Input   Output
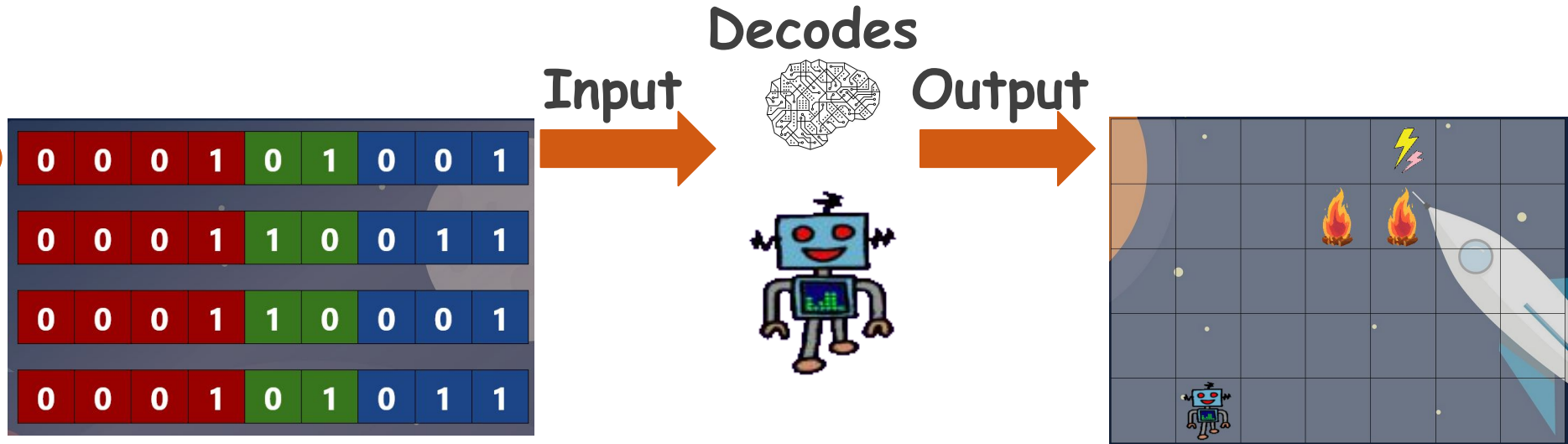
Mr. Robo: After 2nd Instruction

These set of Instructions are executed by brain (CPU) one by one in the given sequence.

Decodes

Input

Output

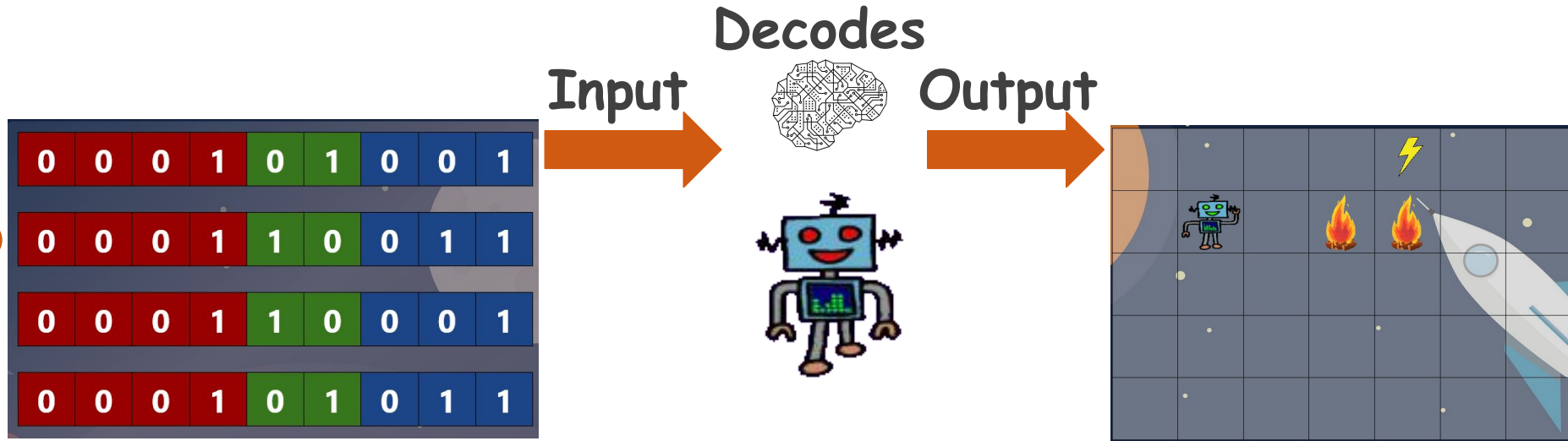| 0	0	0	1	0	1	0	0	1
0	0	0	1	1	0	0	1	1
0	0	0	1	1	0	0	0	1
0	0	0	1	0	1	0	1	1

Mr. Robo: After 3rd Instruction

These set of Instructions are executed by brain (CPU) one by one in the given sequence.

Input → Decodes → Output

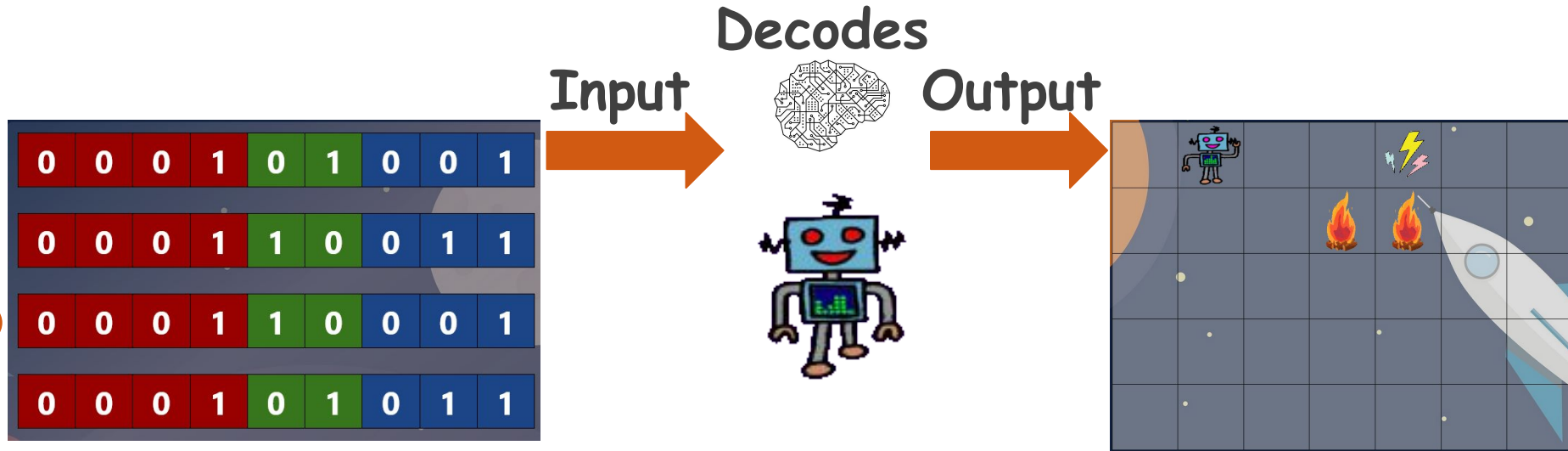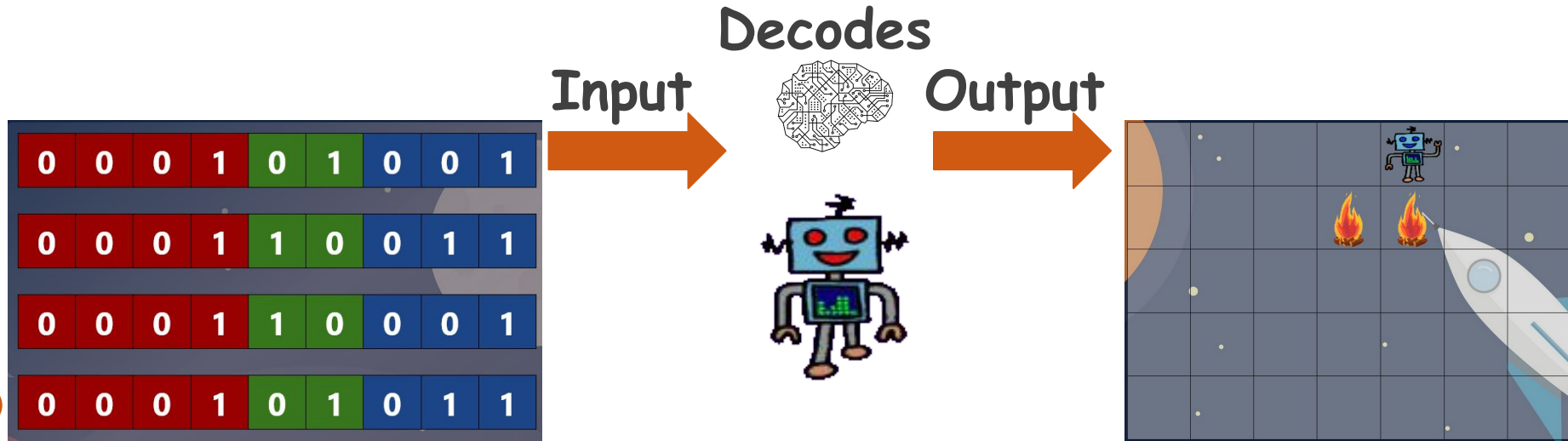| 0	0	0	1	0	1	0	0	1
0	0	0	1	1	0	0	1	1
0	0	0	1	1	0	0	0	1
0	0	0	1	0	1	0	1	1

Mr. Robo: After 4th Instruction

These set of Instructions are executed by brain (CPU) one by one in the given sequence.

Decodes

Input

Output

0	0	0	1	0	1	0	0	1
0	0	0	1	1	0	0	1	1
0	0	0	1	1	0	0	0	1
0	0	0	1	0	1	0	1	1

Mr. Robo: Program

These set of Instructions are called a **Program** and it is executed by brain (**CPU**) one by one in the given sequence.

Decodes

Input

Output

0	0	0	1	0	1	0	0	1
0	0	0	1	1	0	0	1	1
0	0	0	1	1	0	0	0	1
0	0	0	1	0	1	0	1	1

Mr. Robo: Summary

- Mr. Robo is an electronic machine that understand **binary** language.
- Mr. Robo has predefined **operation codes** to perform an action.
- We can give Mr.Robo an **instruction** that consist of operation code in a specific sequence.
- A useful task may consist of multiple instructions; these set of instructions are called **program.**
- Giving Instruction in binary language is difficult therefore, we prefer to give instruction in **English like language**.
- However Mr Robo do not understand English; therefore, we need **compiler** to convert it to binary language.

Action Code	
Move	0 0 0 1
Charge	0 1 0 0

Direction Code	
Left	0 0
Right	0 1
Up	1 0
Down	1 1

Step Code	
Zero Step	0 0 0
One Step	0 0 1
Two Step	0 1 0
Three Step	0 1 1

0	0	0	1	0	1	0	0	1

Mr. Robo: Why we are Studying this?

You Should ask why we are studying Mr. Robo? What it has to do with Computers and Programming?
i.e.

Your subject: Programming Fundamentals

Mr Robo to Computer Programming

- CPU is an electronic machine that understand binary language.
- CPU has predefined operation codes to perform an action.
- We can give an instruction to CPU that consist of multiple operation codes in a specific sequence.
- A useful task may consist of multiple instructions; these set of instructions are called program.
- Humans are more comfortable with English language then binary
- However, CPU do not understand English; therefore, we need compiler to convert it to binary language.

Program: Similarity with Mr. Robo?

Therefore, scientists have made **High Level Languages** to instruct Computers which are close to English language.
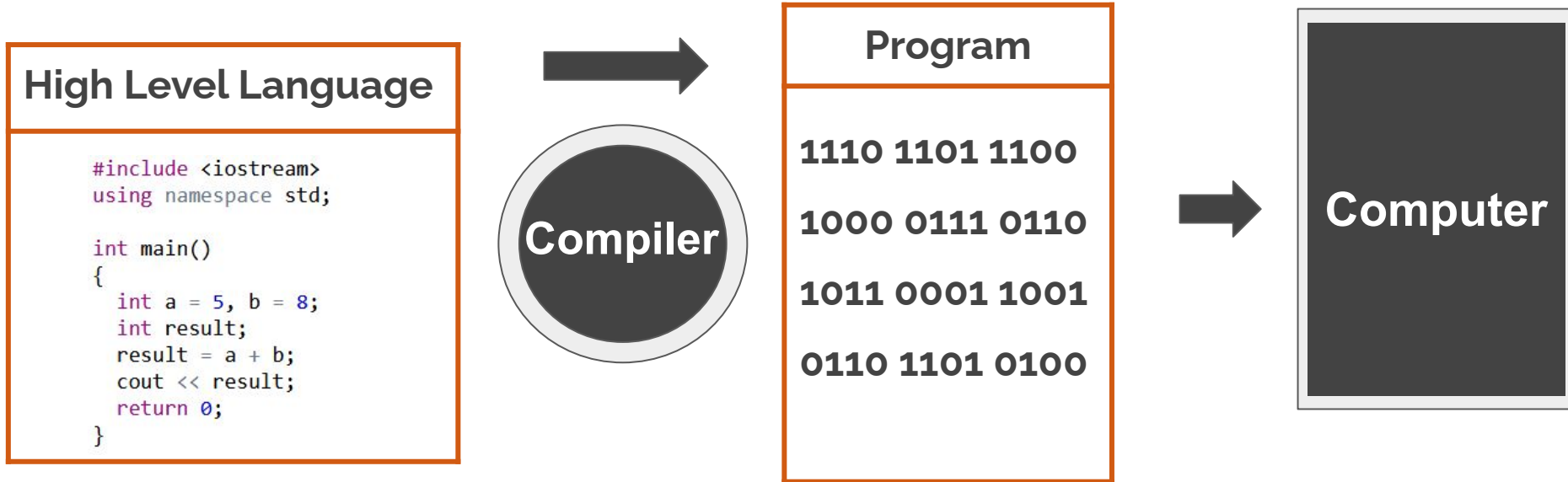
High Level Language

```cpp
#include <iostream>
using namespace std;

int main()
{
  int a = 5, b = 8;
  int result;
  result = a + b;
  cout << result;
  return 0;
}
```
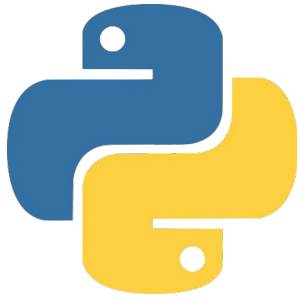
Compiler: Similarity with Mr. Robo?

Compilers convert the **High Level** Language into **Machine** Language.

Language: Similarity with Mr. Robo?

There are many High Level Languages.

Python C++ Java C#

Language: Similarity with Mr. Robo?

We will work in C++.

C++

Learning Objective

Define the **Major Components** of the **Computer** and how it works.

Self Assessment

- **What is the Difference between single computational step and multiple computational step?**
- **What is Machine Language?**
- **Why computer use the Binary Language?**
- **What is the Role of Compiler?**
- **In which language, it is easy for Programmers to write their Programs? Binary or High Level Language?**

Conclusion

- One instruction is called **one Computation Step** because this is a unit task that CPU can perform.
- Some tasks cannot be done in single computational step, therefore, we provide **multiple computational steps** to the CPU to solve those tasks
- **Binary** is the only language that the computer understands, therefore it is also known as **Machine language**
- **Compiler** is a computer program that converts the complete program written in high level language into the machine language.
- Writing code in a low level language (binary language) is very difficult; therefore, programmers write code in a **high level language** that is understandable by humans