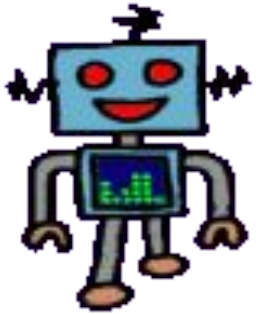
Components of a Machine And how it works

اَللّٰهُمَّ اُرْزُقْنِى عِلْمًا نَافِعًا وَاسِعًا عَمِيْقًا

اَللّٰهُمَّ اُرْزُقْنِى رِزْقًا وَاسِعًا حَلَالًا طَيِّبًا
مُبَارَكًا مِنْ عِنْدِكَ

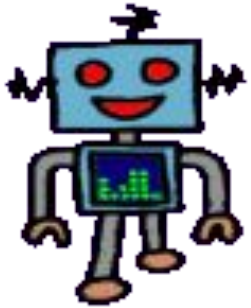
Mr. Robo: Machine

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



Mr. Robo: Machine

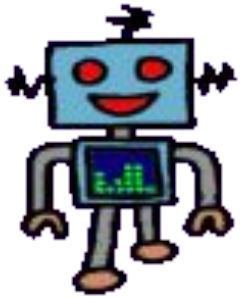
These are the possible words that Mr. Robo understands.



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.**



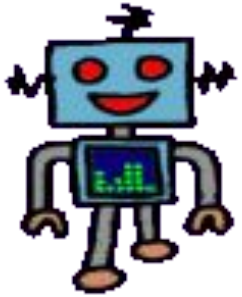
Instructions	
Action Code	
Move	0 0 0 1
Charge	0 1 0 0
Direction Code	
Left	0 0
Right	0 1
Up	1 0
Down	1 1
Step Code	
Zero Step	0 0 0
One Step	0 0 1
Two Step	0 1 0
Three Step	0 1 1

Mr. Robo: Instruction

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

0001 01 001

is a complete instruction that move Robo one step right.

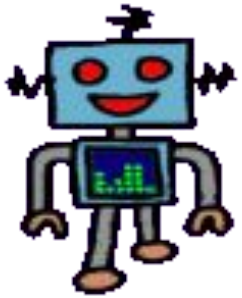


Instructions	
Action Code	
Move	0 0 0 1
Charge	0 1 0 0
Direction Code	
Left	0 0
Right	0 1
Up	1 0
Down	1 1
Step Code	
Zero Step	0 0 0
One Step	0 0 1
Two Step	0 1 0
Three Step	0 1 1

Mr. Robo: Instruction

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

Action Code	Direction Code	Step Code

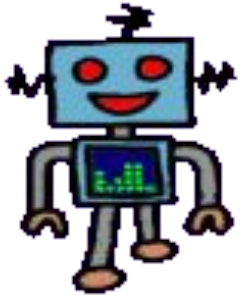


Instructions	
Action Code	
Move	0 0 0 1
Charge	0 1 0 0
Direction Code	
Left	0 0
Right	0 1
Up	1 0
Down	1 1
Step Code	
Zero Step	0 0 0
One Step	0 0 1
Two Step	0 1 0
Three Step	0 1 1

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



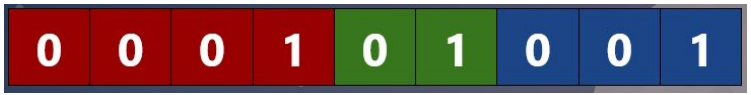
Instructions	
Action Code	
Move	0 0 0 1
Charge	0 1 0 0
Direction Code	
Left	0 0
Right	0 1
Up	1 0
Down	1 1
Step Code	
Zero Step	0 0 0
One Step	0 0 1
Two Step	0 1 0
Three Step	0 1 1

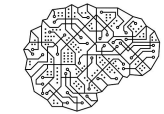
Mr. Robo: CPU (Brain)

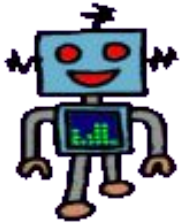
The Brain (Central Processing Unit) of Mr. Robo Decodes the instruction.

Decodes

Input

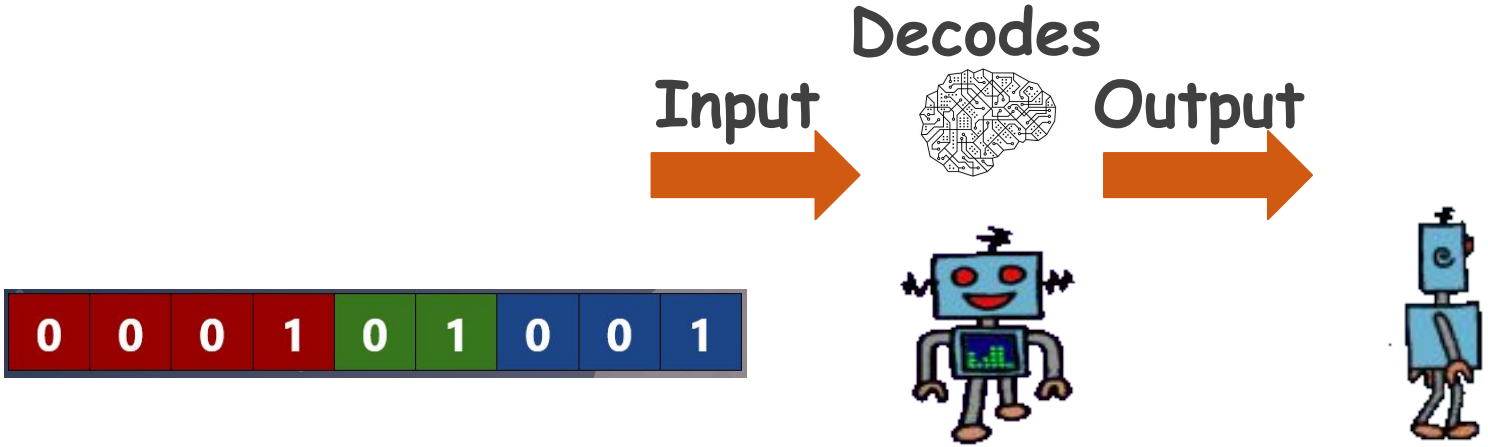






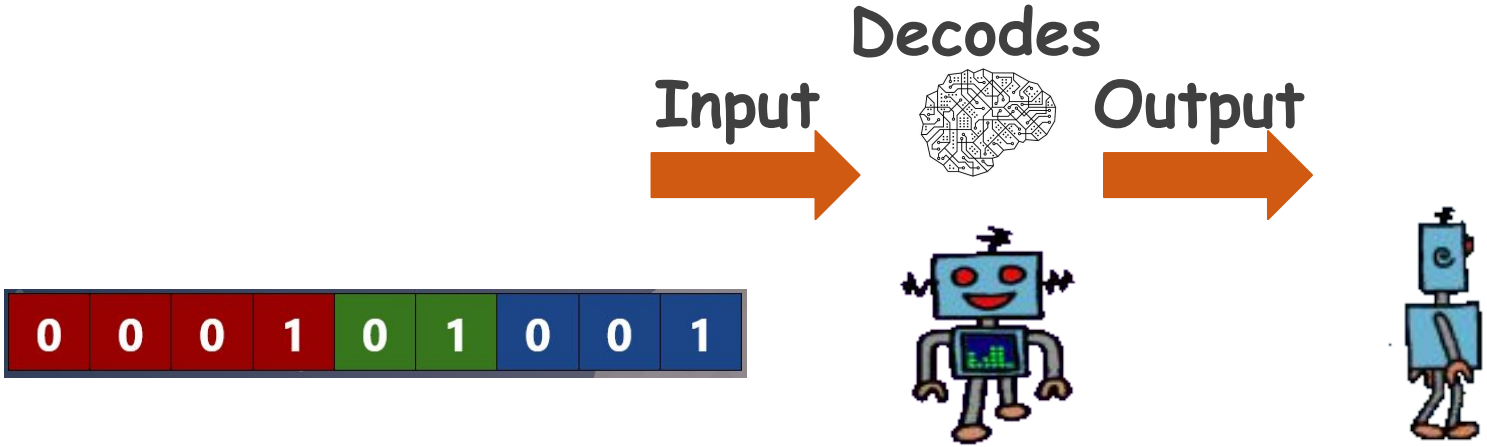
Mr. Robo: Instruction Cycle

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.



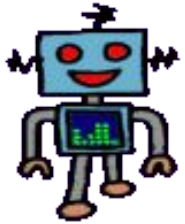
Mr. Robo: Computation Step

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



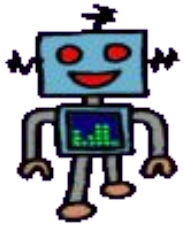
Mr. Robo: Why Understand 0 and 1?

Why Mr. Robo understands only 0 and 1?



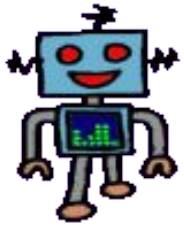
Mr. Robo: Why Understand 0 and 1?

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.



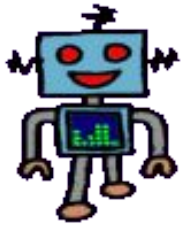
Mr. Robo: Binary Language

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



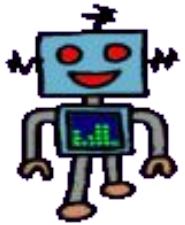
Mr. Robo: Machine Language

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



Mr. Robo: Binary Language

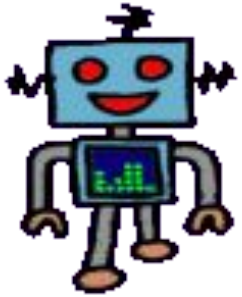
Why Binary? Why not any other language? Binary is so difficult for Us to Remember.



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

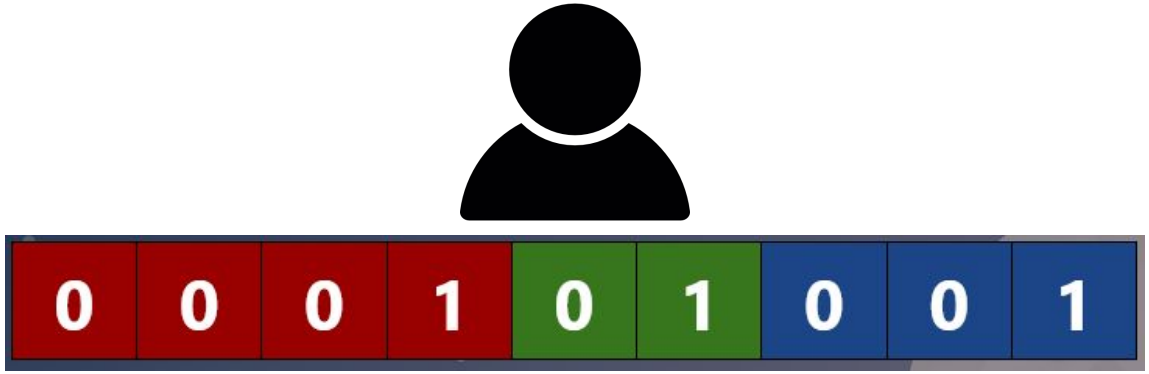


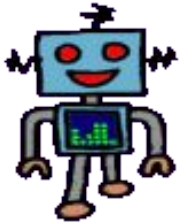
Instructions	
Action Code	
Move	0 0 0 1
Charge	0 1 0 0
Direction Code	
Left	0 0
Right	0 1
Up	1 0
Down	1 1
Step Code	
Zero Step	0 0 0
One Step	0 0 1
Two Step	0 1 0
Three Step	0 1 1

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

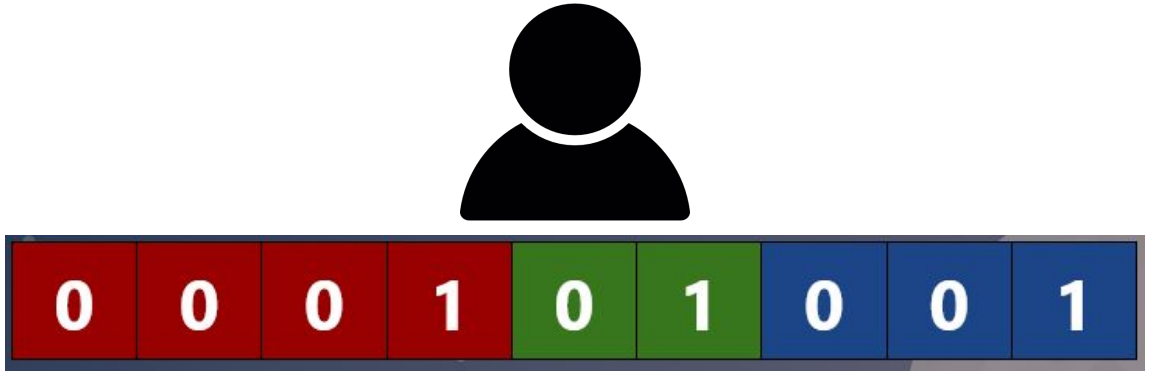


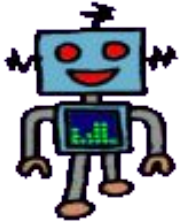


Mr. Robo: Compiler

Such translator is called Compiler.

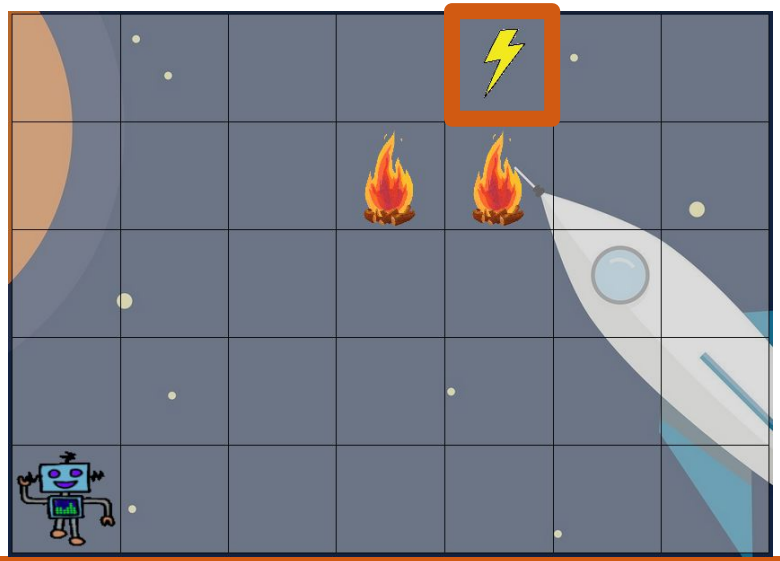
Move Right One Step





Mr. Robo: How to move?

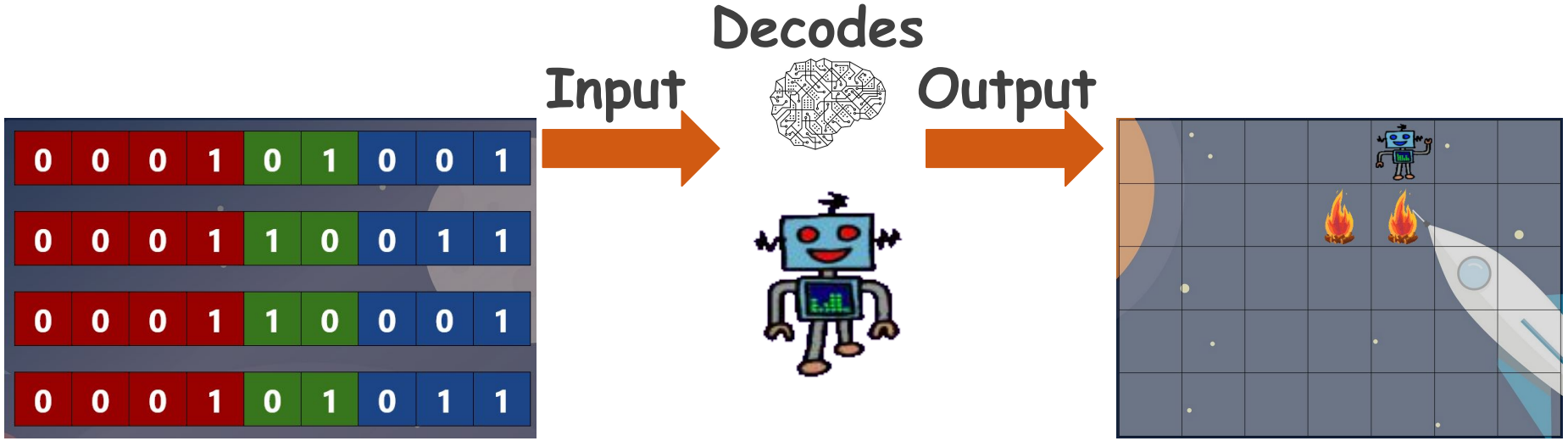
We need Mr. Robo to go to Charge location with these available Operation Codes. What do we do?



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

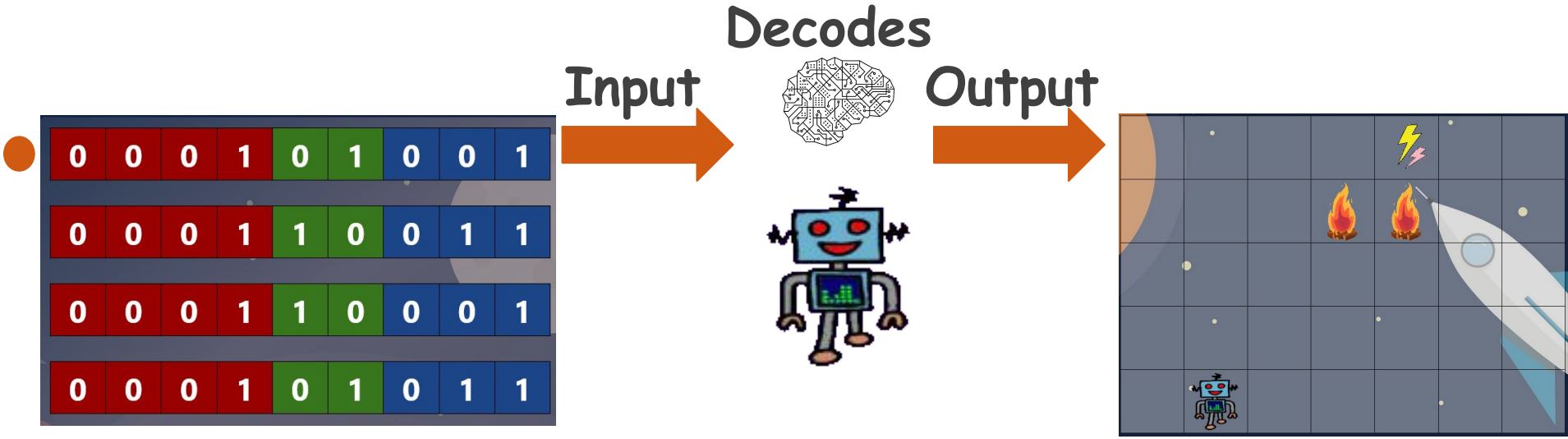
Mr. Robo: Multiple Computation Steps

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.



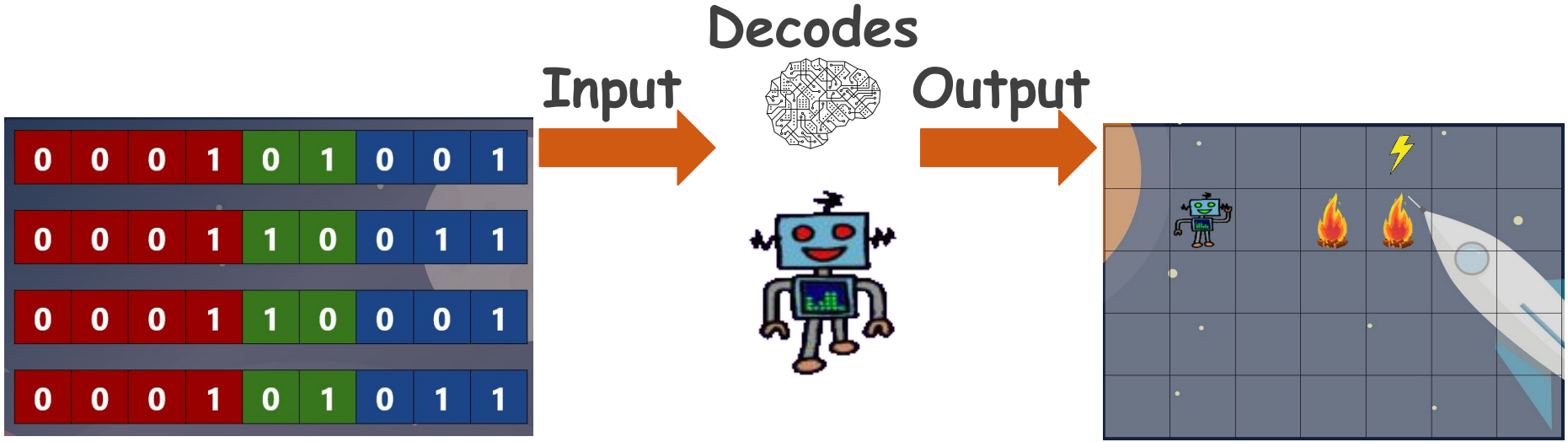
Mr. Robo: After 1st Instruction

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



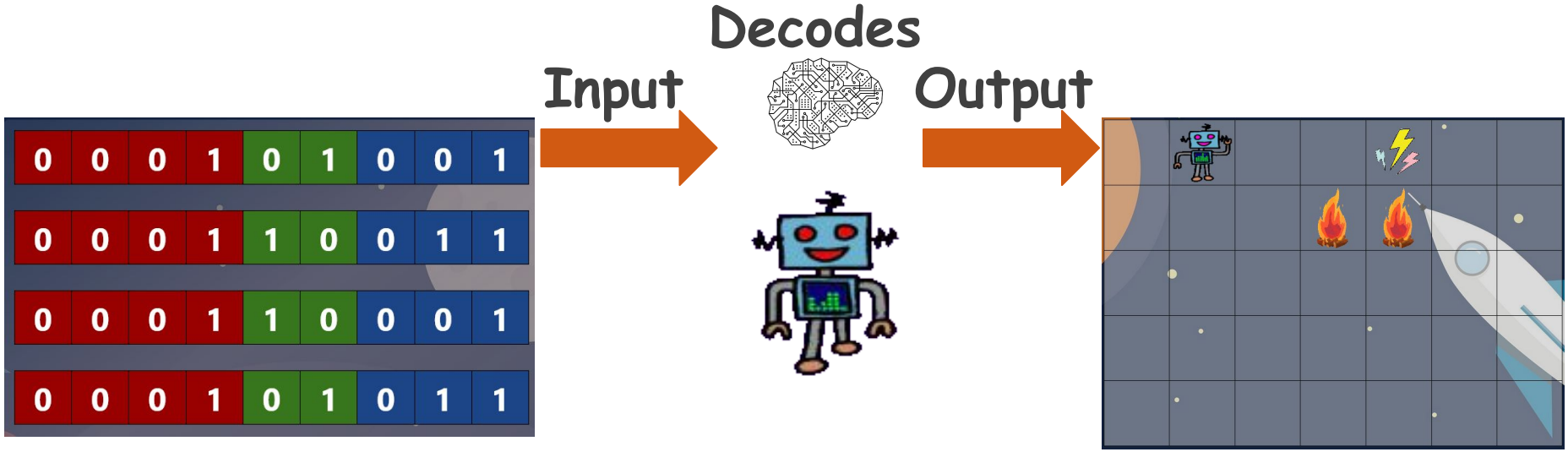
Mr. Robo: After 2nd Instruction

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



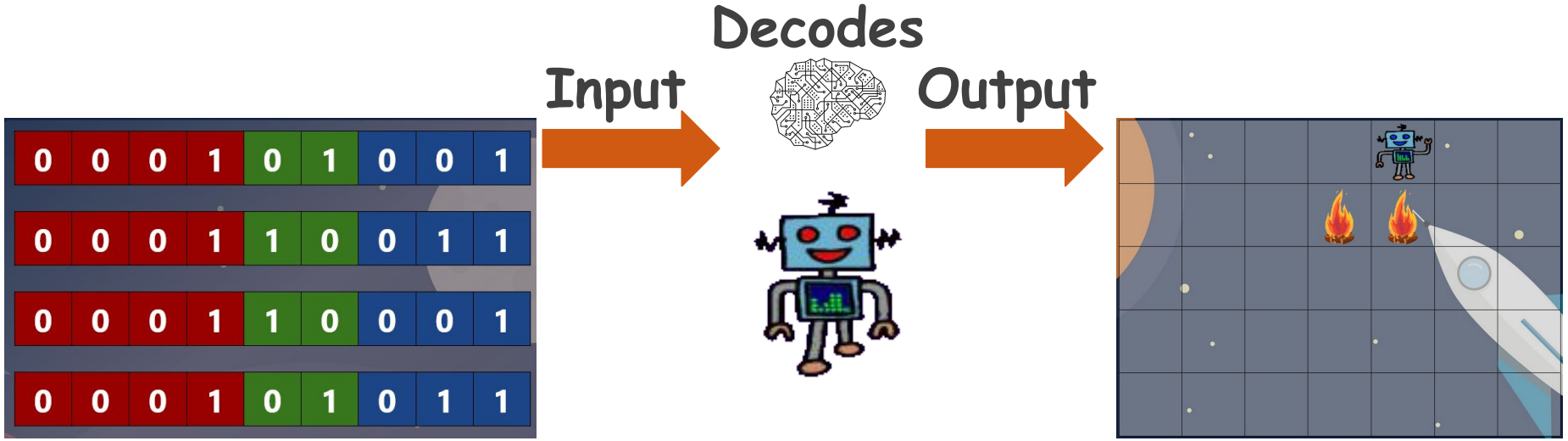
Mr. Robo: After 3rd Instruction

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



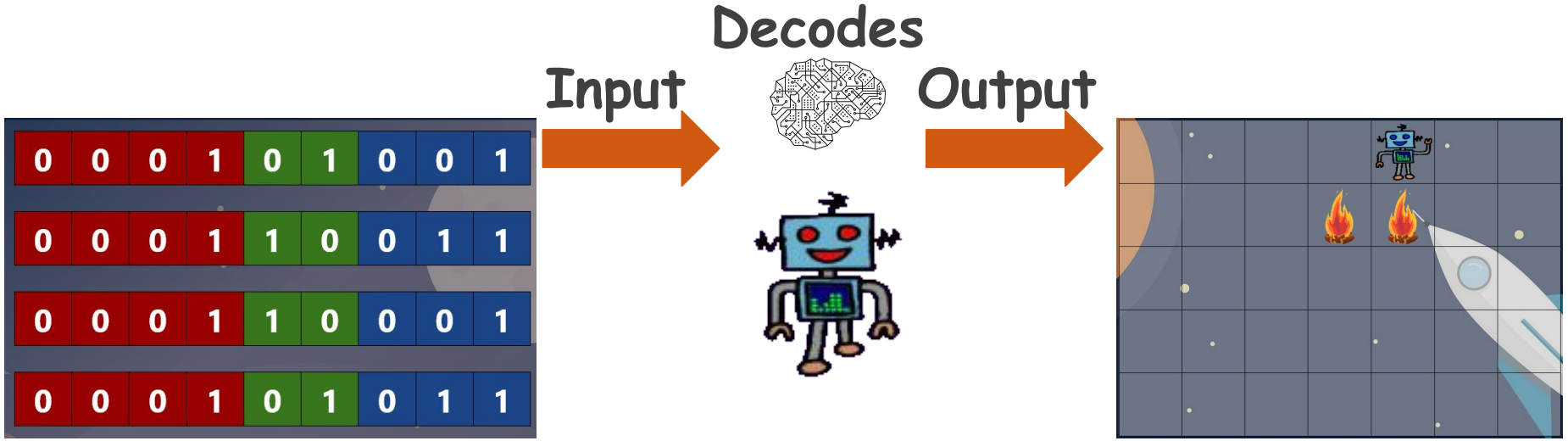
Mr. Robo: After 4th Instruction

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



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.



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

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

Computer: An Electronic Device

Computer is also an Electric Machine that can understand 0 (no or low electricity in wires) and 1 (electricity or high electricity in wires).

Computer: An Electronic Device

Computer only understand 0 and 1.

Binary Language

Computer understands a language that has only two alphabets (0 and 1). This language is called Binary Language.

Machine Language

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

Operation Codes

Using the combinations of these 0s and 1s, computers can understand different operations that it has to perform.
For Example:

- Addition: 0000
- Subtraction: 0001
- Multiplication: 0010
- Division: 0011
- Load data: 11110000
- Store data: 11110001

Instruction

We combine these operation codes to make a complete **Instruction**.
For example, let's suppose we want the computer to add 7 and 7. Let's assume 7 is represented by 0111.

0000 0111 0111

0000 0111 0111 is a complete instruction.

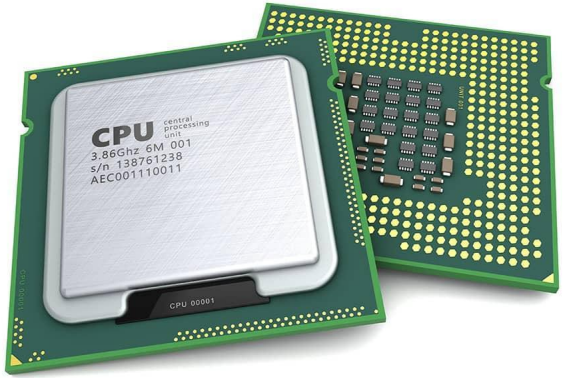
Instruction: Where is it Processed?

Now, the question is where does the Computer Process this Instruction?

0000 0111 0111

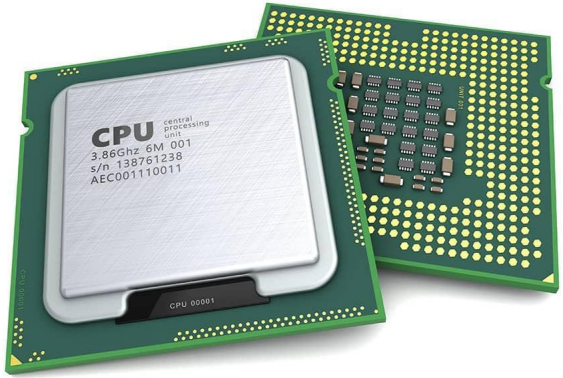
CPU (Brain)

The Brain (Central Processing Unit) of Computer Decodes the instruction.



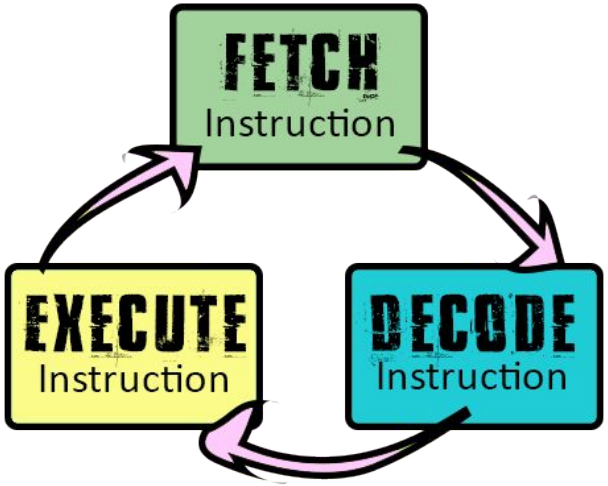
CPU (Brain)

The Brain (Central Processing Unit) of Computer Decodes the instruction.



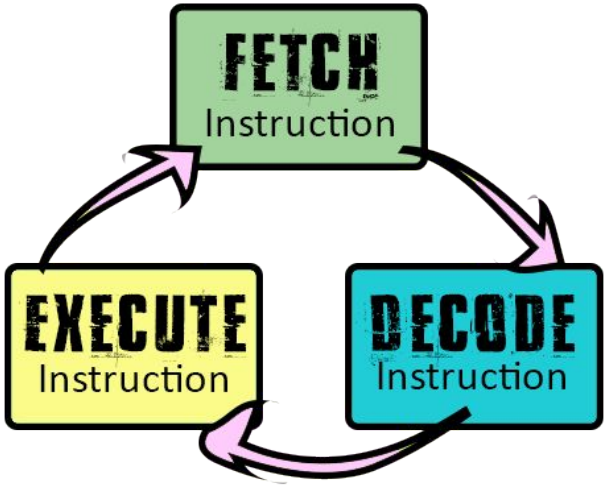
Instruction Cycle

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.



Computation Step

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



Why Binary Language?

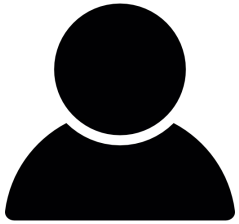
Now, the question is:
Why Binary? Why not any other language?

Binary is so difficult for Us to Remember.

What if?

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

Addition 7 7

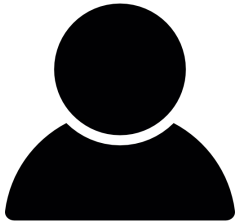


0000 0111 0111

Compiler

Such translator is called Compiler.

Addition 7 7



0000 0111 0111

High Level Programming

To make it easier for humans, scientists developed High Level Languages ((similar to english language) to instruct Computers

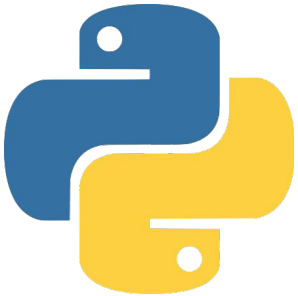
High Level Language

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

int main()
{
  int a = 5, b = 8;
  int result;
  result = a + b;
  cout << result;
  return 0;
}
```

High Level Languages

There are many High Level Languages.



Python

C++

Java

C#

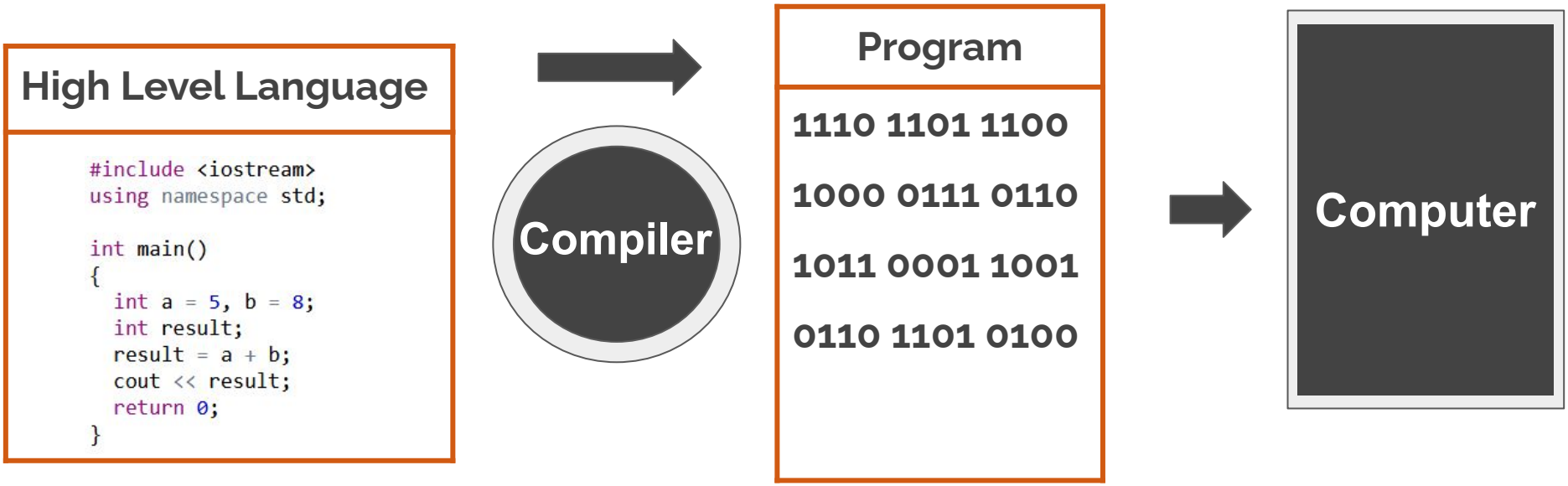
High Level Language: This Course

We will work in C++ in this Course.

C++

Holistic View of Compiler

Compilers convert the High Level Language into Machine Language.



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