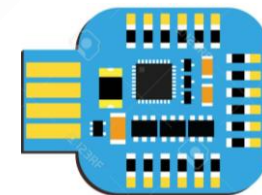# EMBEDDED C LANGUGE

DR. SARWAN SINGH
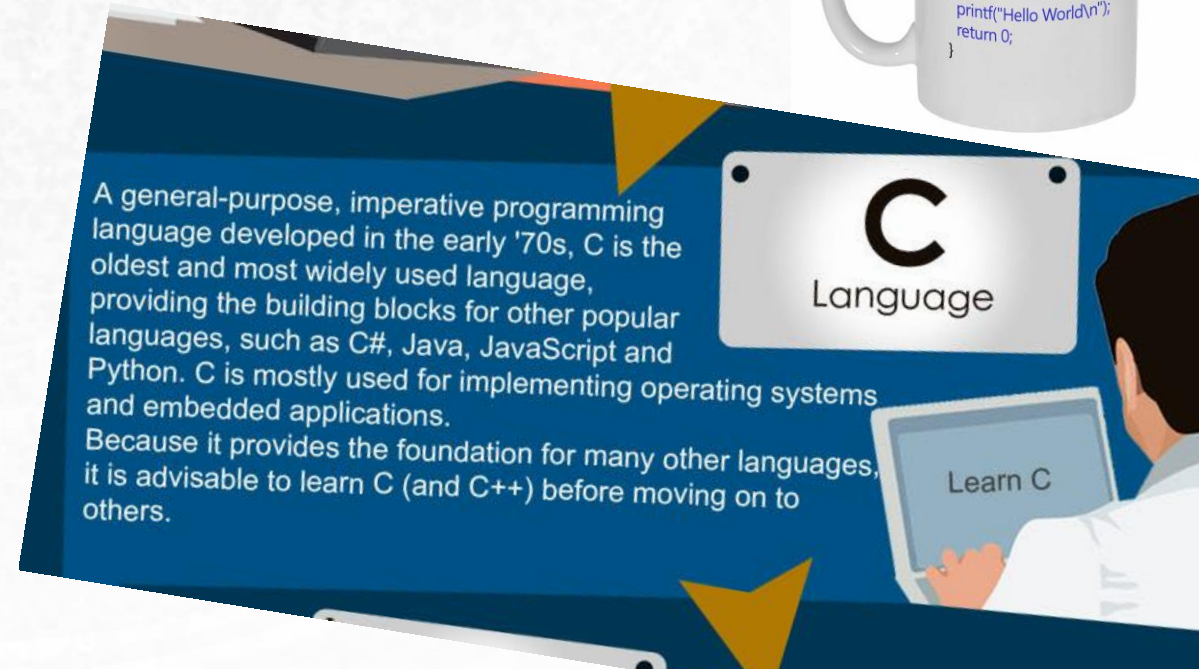
NIELIT CHANDIGARH

AGENDA

- Need of computing languages

- C language – history, uses, applications
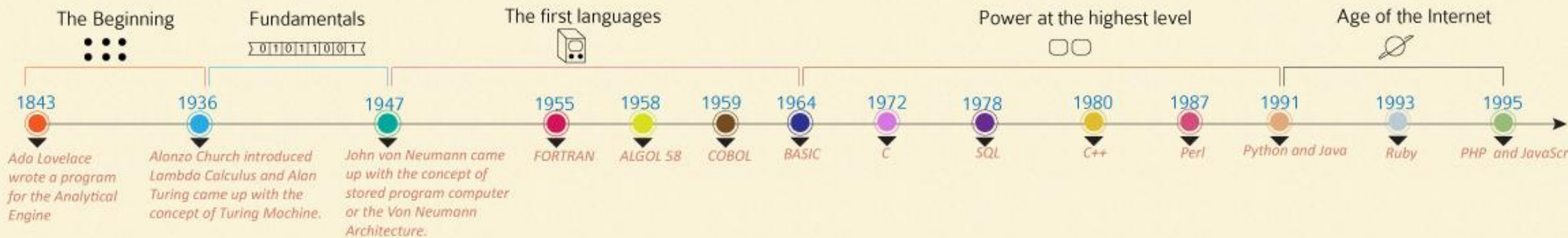
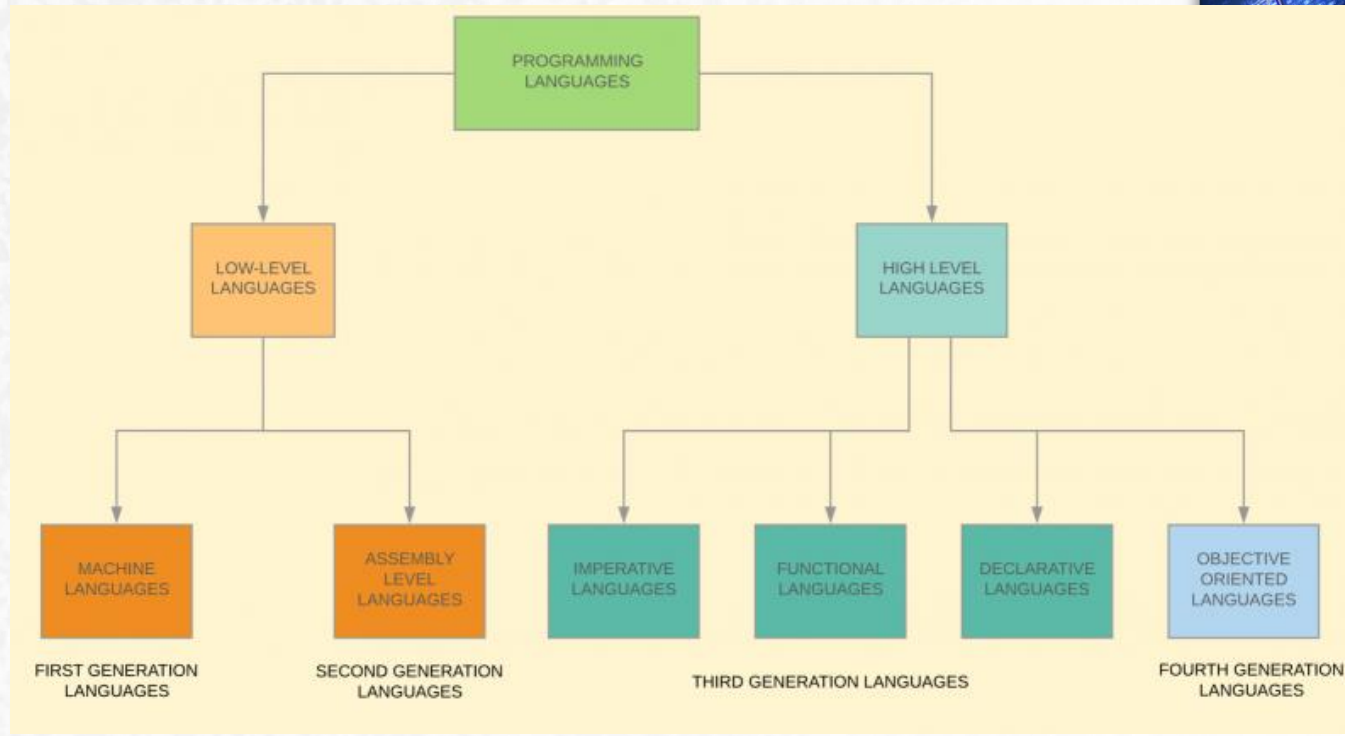A general-purpose, imperative programming language developed in the early '70s, C is the oldest and most widely used language, providing the building blocks for other popular languages, such as C#, Java, JavaScript and Python. C is mostly used for implementing operating systems and embedded applications.
Because it provides the foundation for many other languages, it is advisable to learn C (and C++) before moving on to others.

C Language

Learn C

```
#include <stdio.h>

int main(void)
{
    printf("Hello World\n");
    return 0;
}
```

WORLD OF PROGRAMMING

- sss

Timeline

The Beginning	Fundamentals	The first languages				Power at the highest level			Age of the Internet		

1843	1936	1947	1955	1958	1959	1964	1972	1978	1980	1987	1991	1993	1995
Ada Lovelace wrote a program for the Analytical Engine	Alonzo Church introduced Lambda Calculus and Alan Turing came up with the concept of Turing Machine.	John von Neumann came up with the concept of stored program computer or the Von Neumann Architecture.	FORTRAN	ALGOL 58	COBOL	BASIC	C	SQL	C++	Perl	Python and Java	Ruby	PHP and JavaScr

Programming Languages hierarchy:

PROGRAMMING LANGUAGES
- LOW-LEVEL LANGUAGES
  - MACHINE LANGUAGES — FIRST GENERATION LANGUAGES
  - ASSEMBLY LEVEL LANGUAGES — SECOND GENERATION LANGUAGES
- HIGH LEVEL LANGUAGES
  - IMPERATIVE LANGUAGES
  - FUNCTIONAL LANGUAGES
  - DECLARATIVE LANGUAGES — THIRD GENERATION LANGUAGES
  - OBJECTIVE ORIENTED LANGUAGES — FOURTH GENERATION LANGUAGES

Language Paradigm

- **Imperative Paradigm**
  - Procedural — C, Pascal
  - Object Oriented — C++, Java
- **Declarative Paradigm**
  - functional — LISP
 - logical — Prolog

THE WORLD OF
PROGRAMMING
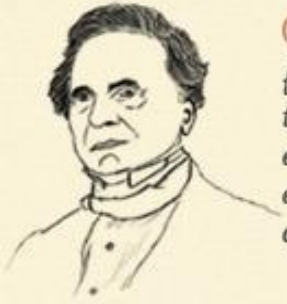
Charles Babbage

{He first came up with the idea of difference engine & analytical engine and is regarded as father of computer}
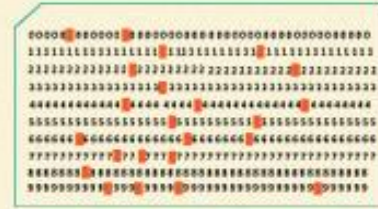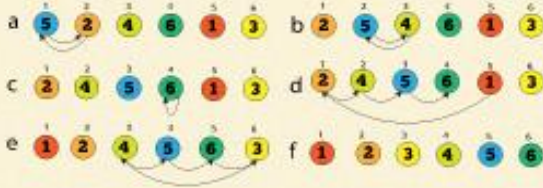
// A Punch Card

Alan Turing

{He is well known for the Halting problem, Turing machines, crypto-analysis of Enigma & Turing test. Turing award is given annually for exceptional work in the field of computing}
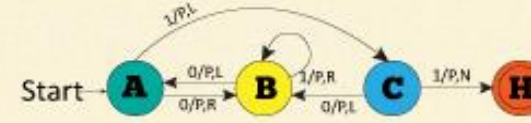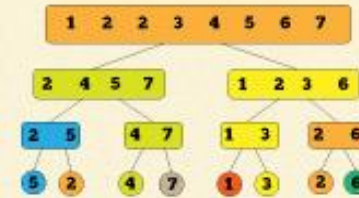
// 3 state busy beaver machine

Start → A ← B ← C → H

// Insertion Sort algorithm

Ada Lovelace

{Wrote a program to calculate sequence of Bernoulli's number using analytical engine. Regarded as World's first programmer}

// Merge sort algorithm

John von Neumann

{He came up with the concept of stored program computer that uses a CPU and a separate storage to hold both instructions and data. This is also known as von Neumann architecture}
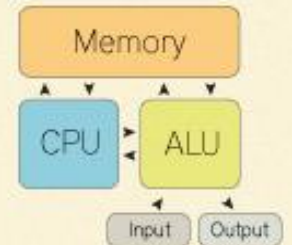
Dennis Ritchie

{He is the creator of C programming language and was also amongst the key developers of UNIX operating system. He received the Turing award in 1983}

// Dijkstra's algorithm

Edsger Dijkstra

{He is known for Dijkstra's algorithm, which is a graph search algorithm that solves the single-source shortest path problem for a graph with nonnegative edge
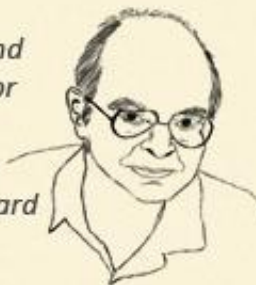
// Von Neumann Architecture

Memory

CPU ALU

Input Output

// B-Tree

42
18 26
67 84
3 5 9 13 15 21 24 31 34 46 51 70 75 82 92 96

Donald Knuth
{He is the creator of TEX and MMIX and is well known for the "Art of computer programming" book series. He received the Turing Award in 1974}

// Binary Search Tree

8
3 10
1 6 14
4 7 13

John Backus
{He is well known for the development of FORTRAN and ALGOL. He is also the inventor of Backus-Naur form and has also helped to popularize functional level programming}

Ken Thompson
{He is well known as the principal creator of the UNIX operating system and is also the co-creator of the Go programming language}
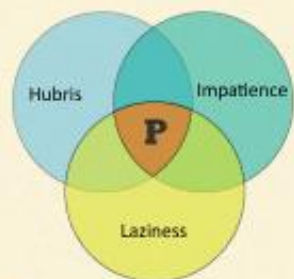
// Google PageRank Algorithm

A 34.3%
B 38.4%
F 3.3%
E 3.9%
D 3.9%
C 8.1%

Bjarne Stroustrup
{He is well known for the creation and development of C++programming language and currently holds the college of engineering chair in computer science at Texas A&M.}
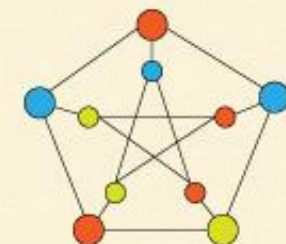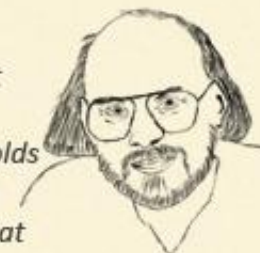
// Graph Coloring Algorithm

Hubris Impatience
P
Laziness

// 3 virtues of a Programmer - Impatience, Laziness and Hubris

Larry Wall
{He is well known for the creation of Perl programming language and is also the first recepient of the Free Software Foundation Award for the Advancement of Free Software}
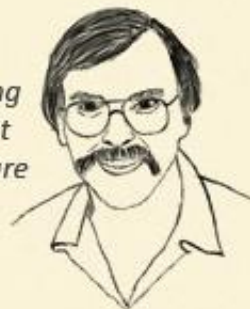
// Sweep line algorithms can be used for generating a Voronoi diagram

James Gosling
{ He is known as the father of Java programming language and is also the creator of Gosmacs, which was the first Emacs to run under UNIX}

Guido van Rossum

{He is well known as the author of Python programming language and is currently employed by Google}
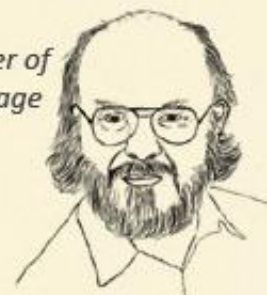
```
>+++++++++++>+>+[
  [+++++[>++++++++<-]>.<++++++[>-------<-]+<<<]>.>>[
  [-]<[>+<->>[<<+>+>-]<[>+<-]<[>+<-[>+<-[>+<-[>+<-[>+<-
  [>+<-[>+<-[>+<-[>[-]>+>+<<<-[>+<-]]]]]]]]]]+>>>
  ]<<<
]
```

// Infinite Fibonacci sequence in Brainfuck language

Richard Stallman

{He is the creator of Emacs editor and the lead architect and organizer of the GNU project. He has been actively involved in the free software movement}
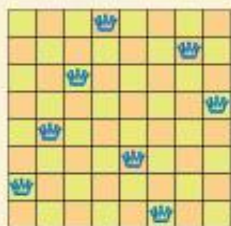
Vim   Emacs

// Vim and Emacs are the two most popular editors amongst "Real Programmers"

// A solution to the Eight Queen Problem

Linus Torvalds

{He is best known for having initiated the development of Linux Kernel and the Git revision control system. He is also a strong supporter of Open Source software}

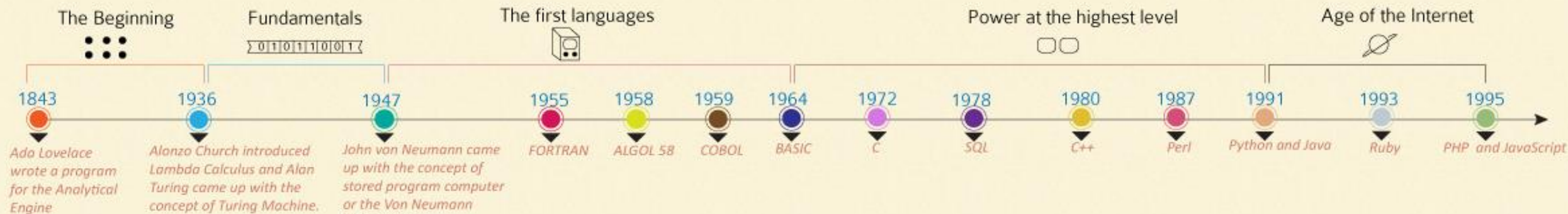| 1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	

// 15 puzzle - A version of the classic n-puzzle

Bill Joy

{He is the co-founder of Sun Microsystems and is also the creator of vi editor,csh and NFS. He was also a primary figure in the development of Java programming language}

Timeline

The Beginning

Fundamentals
010011001

The first languages

Power at the highest level

Age of the Internet

1843	1936	1947	1955	1958	1959	1964	1972	1978	1980	1987	1991	1993	1995
			FORTRAN	ALGOL 58	COBOL	BASIC	C	SQL	C++	Perl	Python and Java	Ruby	PHP and JavaScript

Ada Lovelace wrote a program for the Analytical Engine

Alonzo Church introduced Lambda Calculus and Alan Turing came up with the concept of Turing Machine.

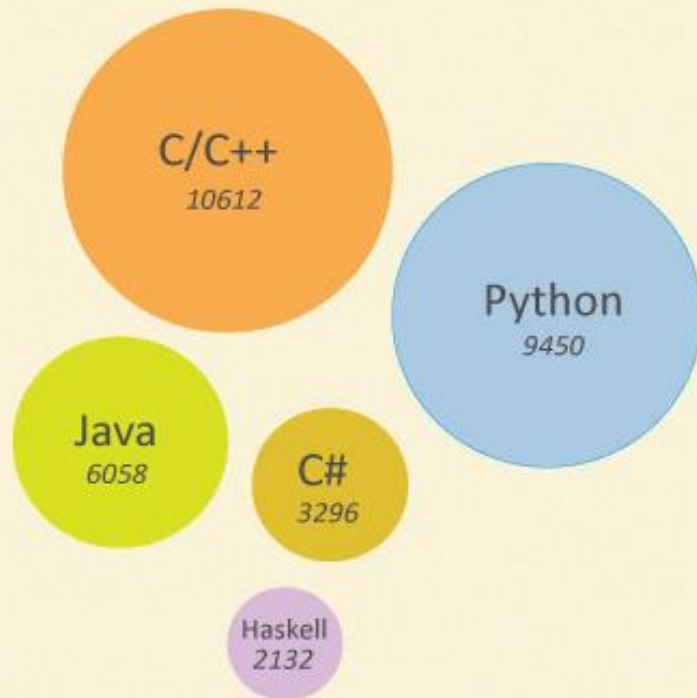*John von Neumann came up with the concept of stored program computer or the Von Neumann Architecture.*

Project Euler

Project Euler is a series of challenging mathematical/computer programming problems. Following stat depicts the top five programming languages by most number of users.

C/C++
10612

Python
9450

Java
6058

C#
3296

Haskell
2132

StackOverflow

Stack Overflow is a website featuring questions and answers on a wide range of topics in computer programming. Following stat depicts the top three programming languages by most numbers of questions asked.

C# - 73906

```
using System;
class ExampleClass
{
    static void Main()
    {
        Console.WriteLine("Hello, world!");
    }
}
```

Java - 43034

```
public class HelloWorld {
    public static void main(String args[]) {
        System.out.println("Hello, world!");
    }
}
```

PHP - 35390

```
<?php
    echo "Hello World";
?>
```

Tiobe Index

The TIOBE Programming Community index gives an indication of the popularity of programming languages. The index is updated once a month. Following stat depicts the top three programming languages for April 2010.

1
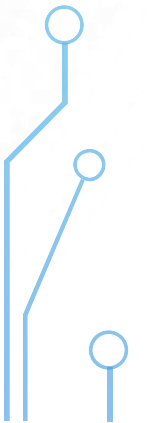
```
x □—
root@abc-desktop:-$  gcc top.c -o top
```

C

2

```
x □—
root@abc-desktop:-$  javac second.java
```

Java

3

```
root@abc-desktop:-$  g++ third.cpp  -o third
```

C++
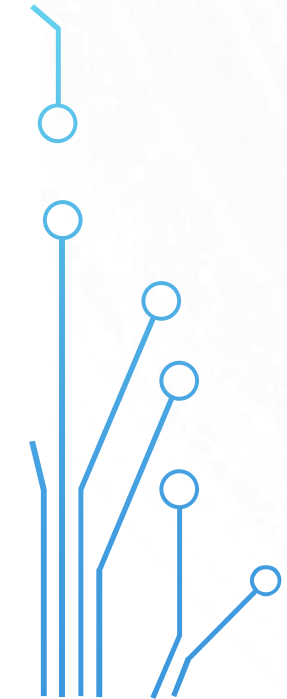
C LANGUAGE

Year	Language	
1960	Algol	• International Group
1967	BCPL	• Martin Richards
1970	B	• Ken Thomson
1972	Traditional C	• Dennis Ritchie
1978	K&R C	• kernighan & Ritchie
1989	ANSI C	• ANSI Commitee
1990	ANSI/ISO C	• ISO Commitee
1999	C99	• Standerd Commitee

- Creator of C Programming lang. and Creator of UNIX operating System
- 1941-2011
- Harvard Graduate

Dennis Ritche : With Ken Thompson (Creator of BCPL)

EMBEDDED SYSTEM PROGRAMMING
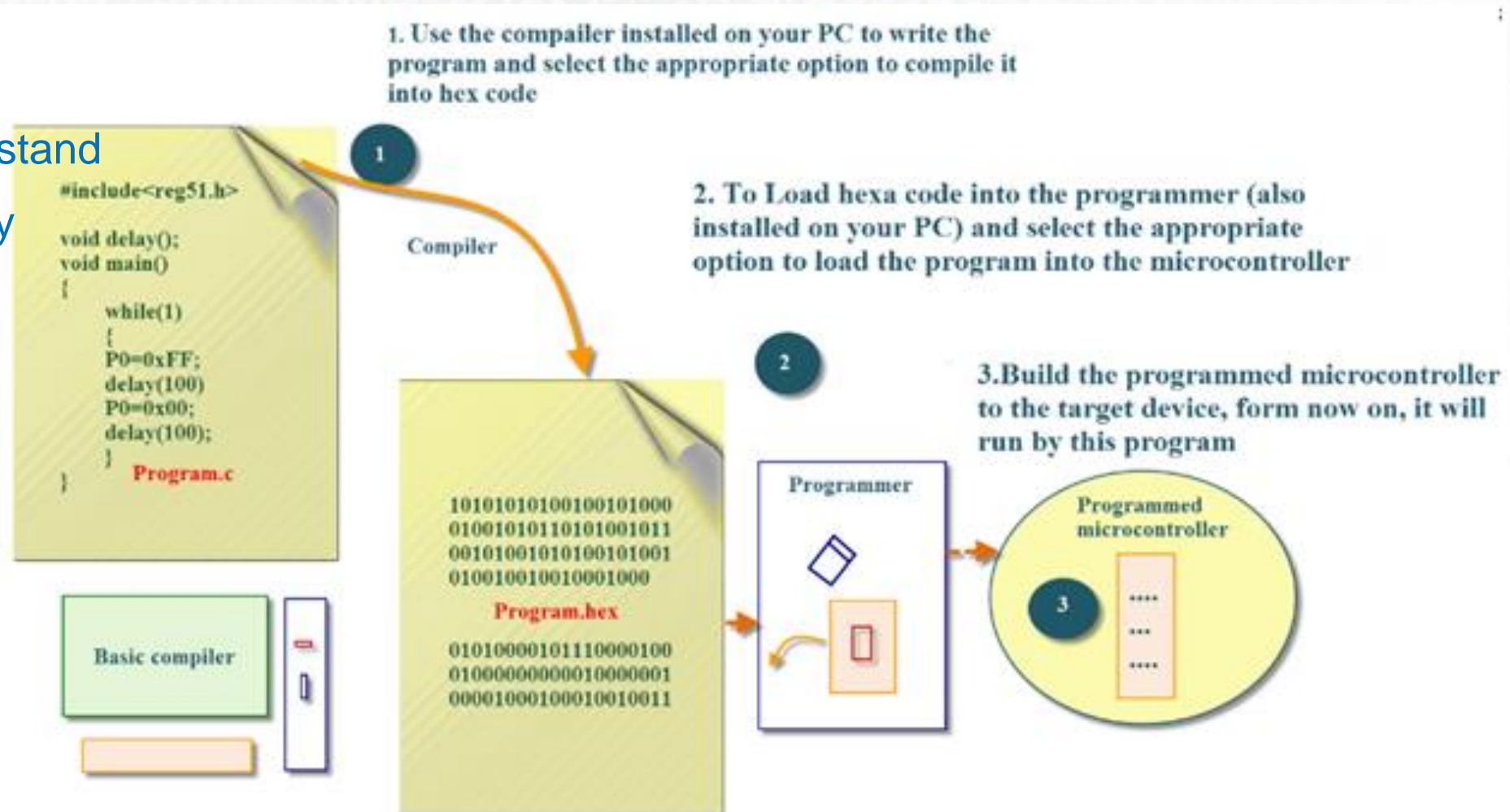
- Most embedded devices used by us, uses microcontroller that are programmed by embedded C

Advantages

- Easy to understand
- High Reliability
- Portability
- Scalability

1. Use the compailer installed on your PC to write the program and select the appropriate option to compile it into hex code

2. To Load hexa code into the programmer (also installed on your PC) and select the appropriate option to load the program into the microcontroller

3. Build the programmed microcontroller to the target device, form now on, it will run by this program

```
#include<reg51.h>

void delay();
void main()
{
    while(1)
    {
    P0=0xFF;
    delay(100)
    P0=0x00;
    delay(100);
    }
}
        Program.c
```

Compiler

Basic compiler

10101010100100101000
01001010110101001011
00101001010100101001
01001001001000101000

Program.hex

01010000101110000100
01000000000010000001
00001000100010010011

Programmer

Programmed microcontroller
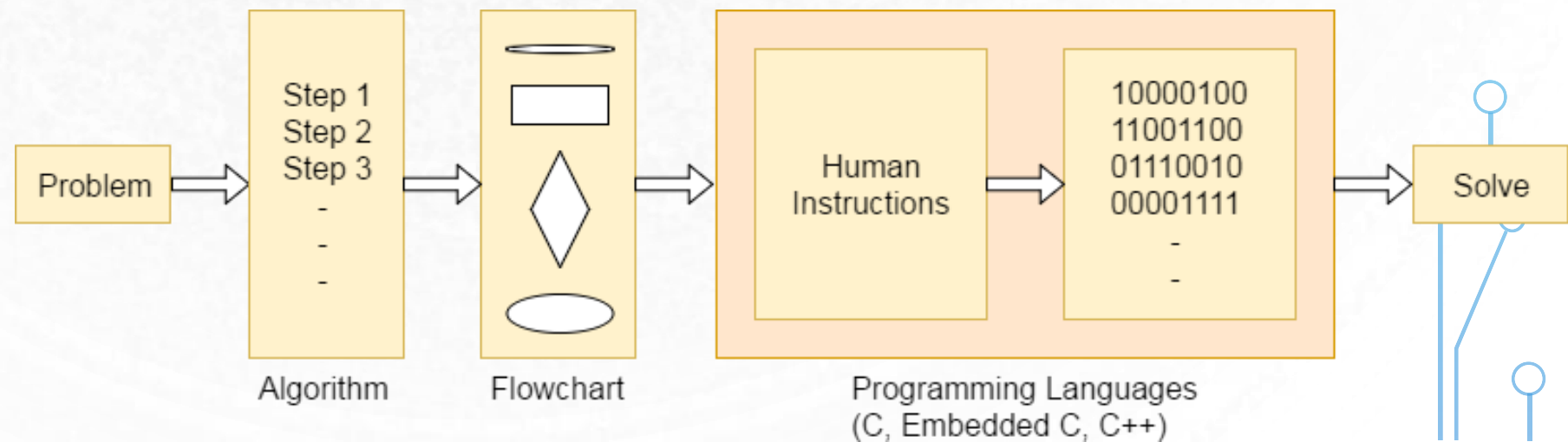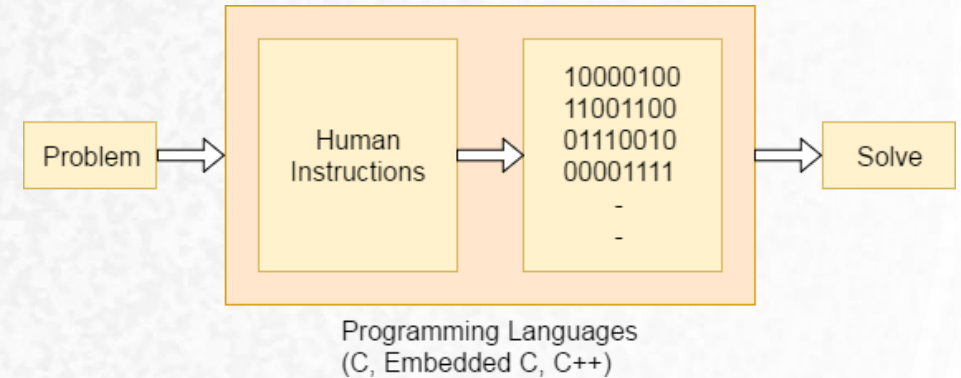
EMBEDDED SYSTEM PROGRAMMING

- block diagram of Embedded C Programming development

- The C language programming is designed for function with variables, character set, data types, keywords, expression and so on

-

Programming Languages
(C, Embedded C, C++)
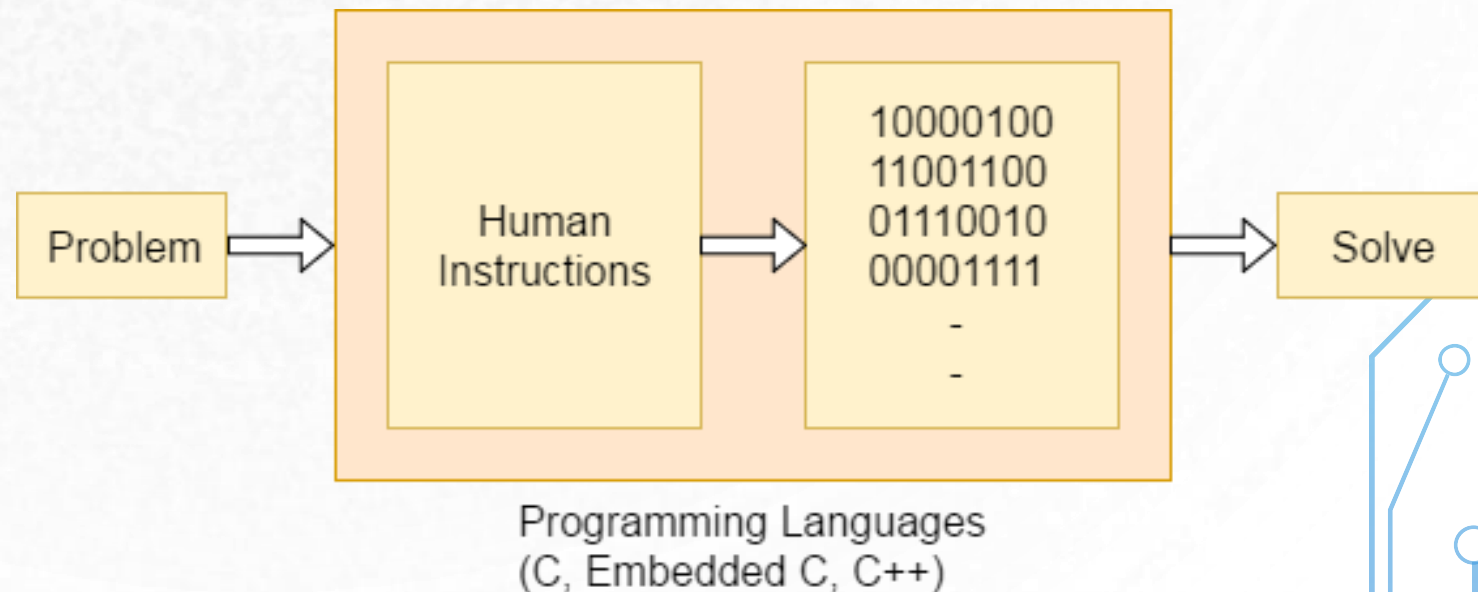
EMBEDDED SYSTEM PROGRAMMING

- The microcontroller programming is different for each type of operating system. Even though there are many operating system are exist such as Windows, Linux, RTOS, etc

Problem → Human Instructions → 10000100 11001100 01110010 00001111 - - → Solve

Programming Languages
(C, Embedded C, C++)

Problem → Step 1 Step 2 Step 3 - - - (Algorithm) → (Flowchart) → Human Instructions → 10000100 11001100 01110010 00001111 - - (Programming Languages (C, Embedded C, C++)) → Solve
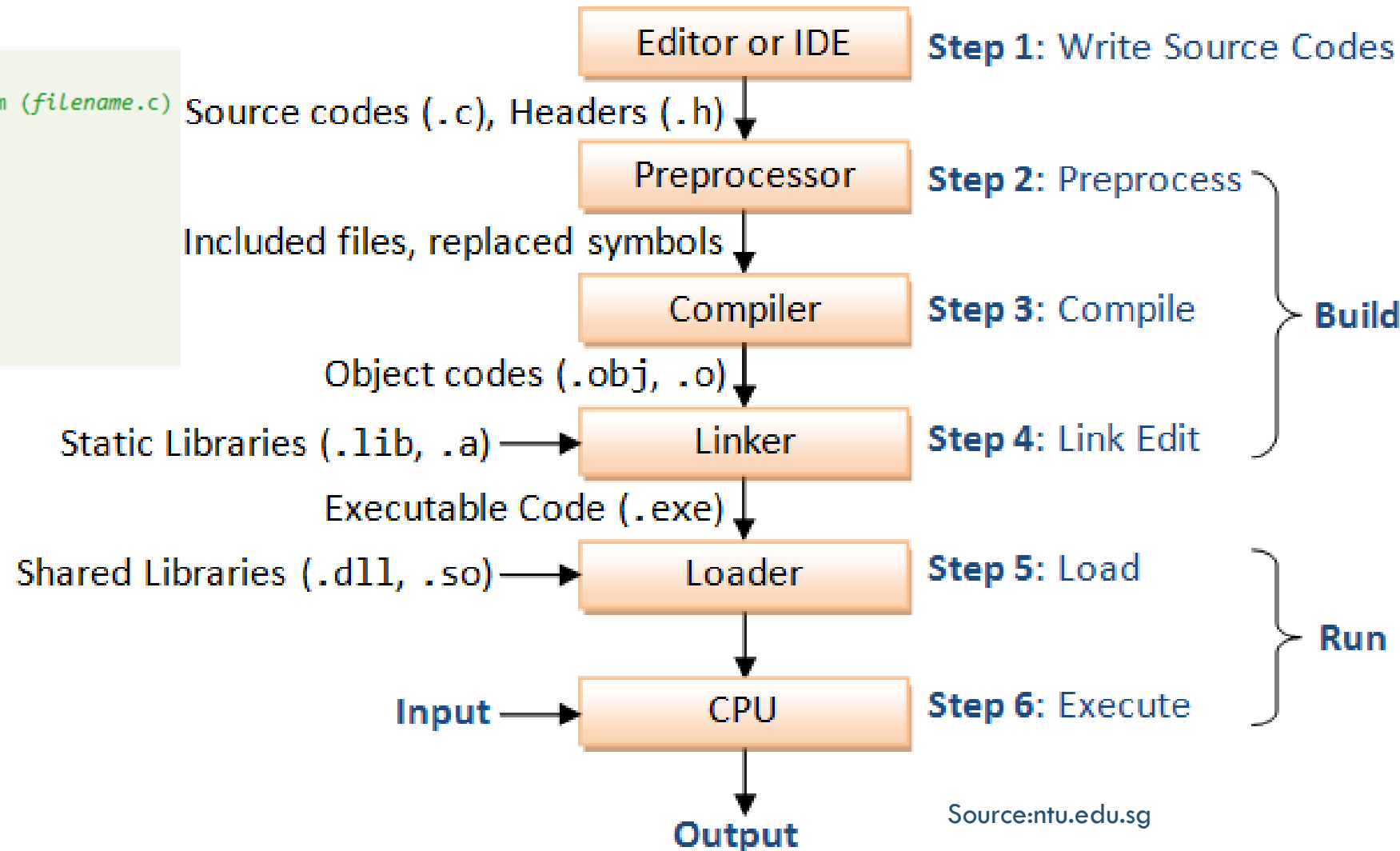
THE PROCESS OF WRITING A C PROGRAM

- Program template

```c
1  /*
2   * Comment to state the purpose of this program (filename.c)
3   */
4  #include <stdio.h>
5
6  int main() {
7      // Your Programming statements HERE!
8
9      return 0;
10 }
```

Editor or IDE — **Step 1**: Write Source Codes

Source codes (.c), Headers (.h)

Preprocessor — **Step 2**: Preprocess

Included files, replaced symbols

Compiler — **Step 3**: Compile

Object codes (.obj, .o)

Static Libraries (.lib, .a) → Linker — **Step 4**: Link Edit

Executable Code (.exe)

Shared Libraries (.dll, .so) → Loader — **Step 5**: Load

Input → CPU — **Step 6**: Execute

Output

Build

Run

Source:ntu.edu.sg

WHAT IS A PROGRAM

- A *program* is *a sequence of instructions* (called *programming statements*), executing one after another - usually in a *sequential* manner, as illustrated in the previous example and the following flow chart.

- C is case sensitive language

- Each declaration statement is terminated with a semi-colon (;).

- In multiple-variable declaration, the names are separated by commas (,)

begin

Statement 1

Statement 2

Statement 3

end

Sequential

Source:ntu.edu.sg