Introduction to Computer Science

"The Analytical Engine has no pretensions whatever to originate anything. It can do whatever we know how to order it to perform. It can follow analysis; but it has no power of anticipating any analytical relations or truths. Its province is to assist us to making available what we are already acquainted with."

Ada Lovelace Describing Charles Babbage's machine

MAP OF COMPUTER SCIENCE

COMPUTATIONAL COMPLEXITY

DOES P≠NP?

NxN CHESS PSPACE NxN GO

NP COMPLETE
TRAVELLING SALESMAN MAP COLOURING

NP GRAPH ISOMORPHISM

BQP
DISCRETE LOGARITHM FACTORING

P

EFFICIENT FOR A QUANTUM COMPUTER

EFFICIENT FOR A COMPUTER

INFORMATION THEORY

0100110100011001

COMPRESSION

ERROR CORRECTION

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

CODING THEORY

ENTROPY PARITY CHECKING

CRYPTOGRAPHY

PUBLIC KEY

ALL THE SECRETS → ?bh; ~ 6m p $ ▲ vr

?bh; ~ 6m p $ ▲ vr → ALL THE SECRETS

PRIVATE KEY

SOUND

MONITOR

SSD

HARDWARE

GPU RAM

INPUT

POWER

CPU

MOTHERBOARD

SCHEDULING

PROCESSES

SCHEDULER

MULTIPROCESSING

COMPUTER ARCHITECTURE

CPU

CENTRAL PROCESSING UNIT
CONTROL UNIT
ARITHMETIC/ LOGIC UNIT
MEMORY UNIT

INPUT OUTPUT

CPU 1 CPU 2 CPU 3 CPU 4

GPU MULTIPROCESSORS

FPGA

LOGIC BLOCK
INTERCONNECTION
INPUT/OUTPUT
SWITCH BOX
CONNECT BLOCK

THEORETICAL COMPUTER SCIENCE

COMPUTABILITY THEORY

ALAN TURING

TURING MACHINE

STATE REGISTER

1: MOVE LEFT
2: MOVE RIGHT
3: FLIP DIGIT

011001110 11010 21001

INFINITELY LONG TAPE

HEAD

123: STOP

LAMBDA CALCULUS

AND MORE

DATA STRUCTURES

TREE LINKED LIST LIST

GRAPH STACK HASHING

FORMAL METHODS

START

POSSIBLE STATES

ALERT

COMPUTER ENGINEERING

SOFTWARE AND PROGRAMMING LANGUAGES

PYTHON JAVASCRIPT WEB APPS

PHP SWIFT PERL BROWSER

JAVA C# SQL APPLICATIONS

C++ OPERATING SYSTEM

ASSEMBLY BIOS

SILICON

JAVASCRIPT COMPILER
C++ COMPILER
C COMPILER
ASSEMBLY COMPILER
COMPILER

MACHINE CODE

COMPILERS

ALGORITHMS

BUBBLESORT(A)
1: GO FROM LEFT TO RIGHT.
2: COMPARE EACH PAIR
3: IF LEFT ONE HIGHER, SWITCH.
4: DO UNTIL NO MORE SWITCHES.

BUBBLE SORT $O(n^2)$

1 2 3 4 5 6 7 8

MERGE SORT $O(n \log n)$

1 2 3 4 5 6 7 8

ANALYSIS OF ALGORITHMS ALGORITHMIC COMPLEXITY

LOGIC

ZERO ONE

NOT

OR

XOR NAND AND

COMPUTATIONAL GEOMETRY

GRAPH THEORY

AUTOMATA THEORY

QUANTUM COMPUTATION

S_1 S_2

$|0\rangle$

$\frac{|0\rangle + |1\rangle}{\sqrt{2}}$

$|1\rangle$

PARALLEL PROGRAMMING

JOB 1
JOB 2
JOB 3
JOB 4

MAIN JOB

SMALLER JOBS

DATA MANAGEMENT

SOFTWARE ENGINEERING

FORMAL METHODS UNIT TESTING VERSION CONTROL

OBJECT ORIENTED DESIGN

OPERATING SYSTEMS

iOS macOS

NETWORKING

CONCURRENT/ DISTRIBUTED/ PARALLEL SYSTEMS

DATABASES SQL DATACENTRES

PERFORMANCE

COMPUTER ANALYSIS

BENCHMARKING

MACHINE LEARNING

SUPERVISED UNSUPERVISED NEURAL NETWORK

CAT

REINFORCEMENT

OPTIMISATION

FINANCE LEAGUE OF LEGENDS

AMAZON WAREHOUSE

BOOLEAN SATISFIABILITY

x_1 OR x_2 OR $\overline{x_3}$ (SAT)

$\overline{x_1}$ OR $\overline{x_2}$ OR x_3

$\overline{x_1}$ OR x_2 OR $\overline{x_3}$

$\overline{x_1}$ OR x_2 OR x_3

SUPER COMPUTING

COMPUTER GRAPHICS

COMPUTATIONAL SCIENCE

COMPUTATIONAL PHYSICS NUMERICAL ANALYSIS

BIOINFORMATICS

COMPUTATIONAL CHEMISTRY

HACKING

COMPUTER VISION

FIND THE HUMANS

ARTIFICIAL INTELLIGENCE

A.I.

ROBOTICS

APPLICATIONS

VIRTUAL REALITY

SIMULATION

BIG DATA

NATURAL LANGUAGE PROCESSING

CHATBOTS
-HEY
HELLO THERE-
-ARE U A ROBOT?
YES-
WAIT, I MEAN NO-
-PROVE IT!
CALCULATING...-
I MADE YOU CAKE-

SCONES TEA FLOUR BUTTER

BIRTHDAY CAKE FOOD

CELEBRATION PANCAKE BACON

BREAKFAST

KNOWLEDGE REPRESENTATION

TELEPRESENCE

AUGMENTED REALITY

HUMAN COMPUTER INTERACTION

YOUTUBE DOMAIN OF SCIENCE MAP OF COMPUTER SCIENCE

INTERNET OF THINGS

IMAGE PROCESSING

- Computational Thinking

- Abstraction in Computer Science

- Algorithm

Computational Thinking

Computational Thinking

|	
Biology	Computational Biology
Chemistry	Computational Chemistry
Physics -->	Computational Physics
Anthropology	Computational Anthropology
History	Computational History
Agriculture	Computational Agriculture
...	Computational ...

Computational +

Computational + Thinking --> Computational Thinking

Abstraction

Binary Light Bulb

Abstraction

123 → 1111011

Abstraction

Text → 84 101 120 116 → 01010100 01100101 01111000 01110100

Abstraction

😏 → 11110000 10011111 10011000 10001111

Abstraction
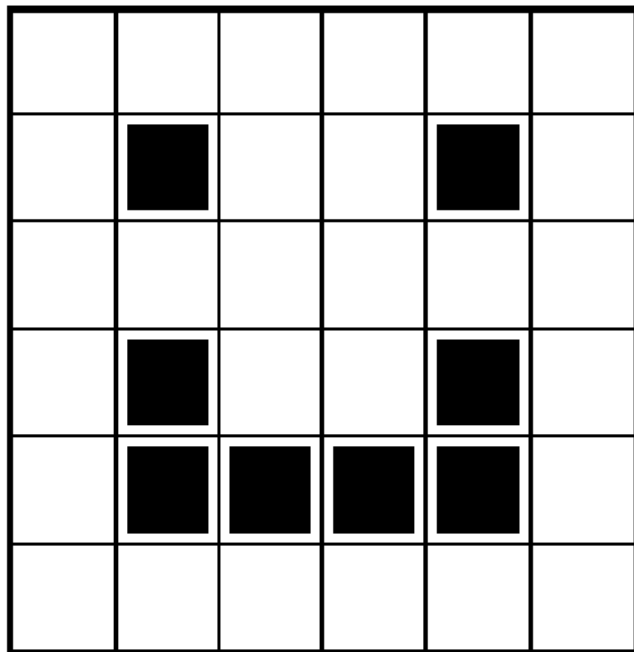

```
1 1 1 1 1 1
1 0 1 1 0 1
1 1 1 1 1 1
1 0 1 1 0 1
1 0 0 0 0 1
1 1 1 1 1 1
```

Abstraction
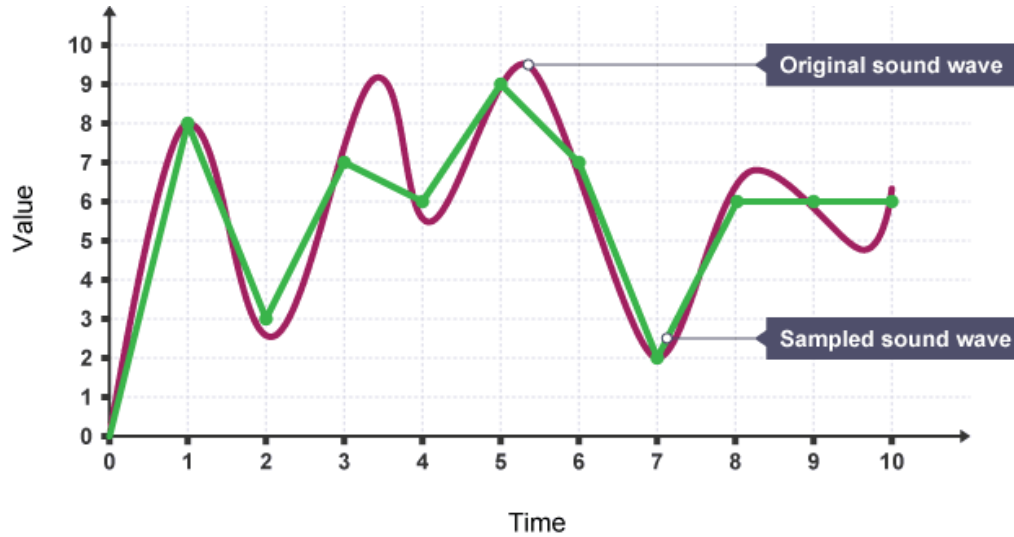
Time sample	1	2	3	4	5	6	7	8	9	10
Denary	8	3	7	6	9	7	2	6	6	6
Binary	1000	0011	0111	0110	1001	0111	0010	0100	0110	0110

Abstraction

Information

Number

Binary number

Algorithm

Input →   Algorithm → Output

Algorithm

- 1000dictionary.py

- random_array_of_number.py

Lightbot Hour