

# CM10194

# Computer Systems

# Architecture I

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# Summary

## In this lecture:

- Computer Science?
- Computer Architecture
  - What's in it, why is it important?
- Some historical perspective

# What is Computer Science?

The study of

- What problems can be solved by computation
- How to solve these problems
- What design choices lead to effective solutions
- The study of the principles and use of computers.
- ...

Several possible answers. (but I like these ones)

Computer science is a discipline that spans theory and practice.

- Graphics/Visual Computing
- Artificial intelligence
- Programming Languages
- Software Engineering
- Networking
- Theory
- Human-Computer Interaction
- Computer architecture
- ...

Python

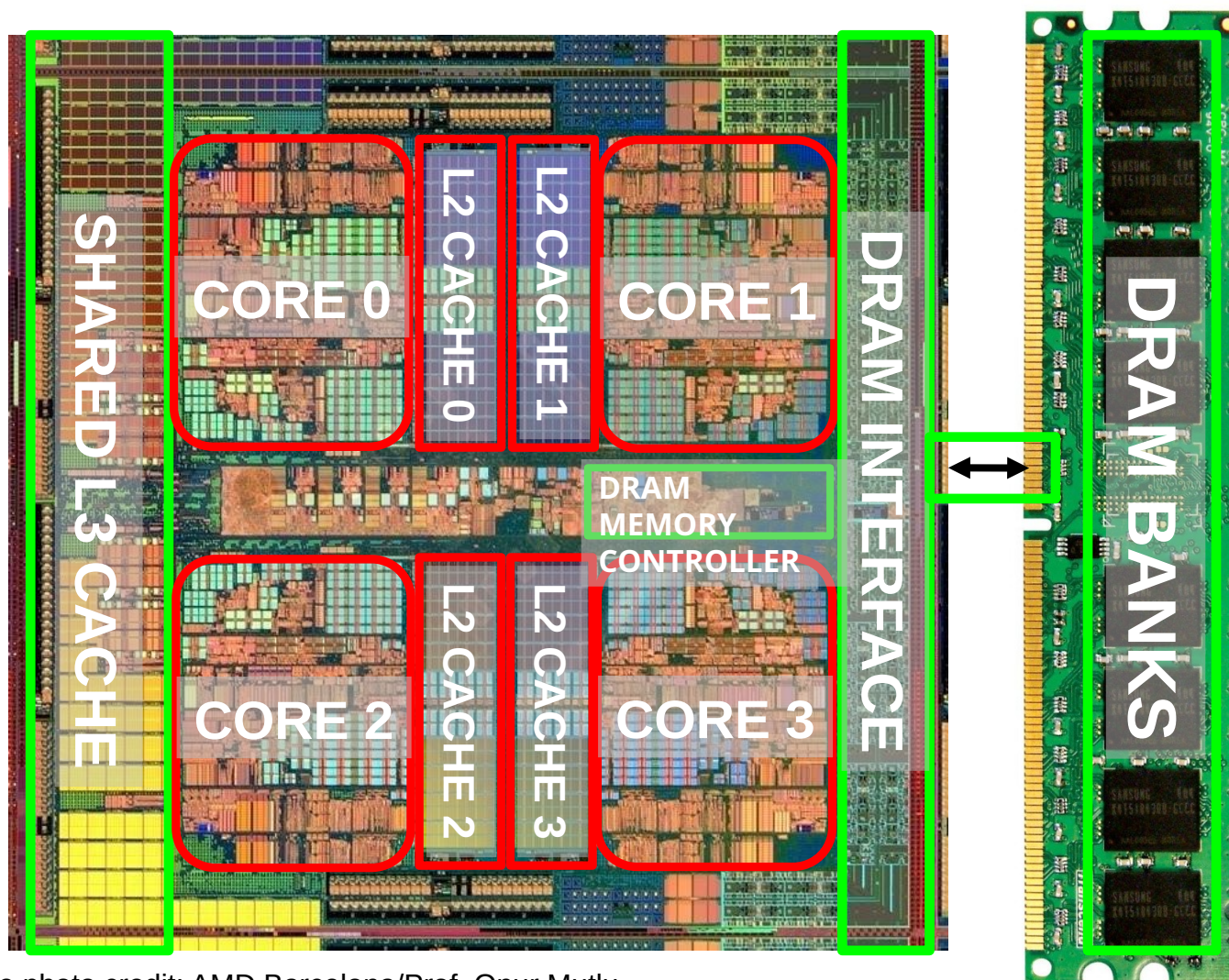
Java

C/C++, Haskell, Rust...

That's us 😊 - but why is it important?

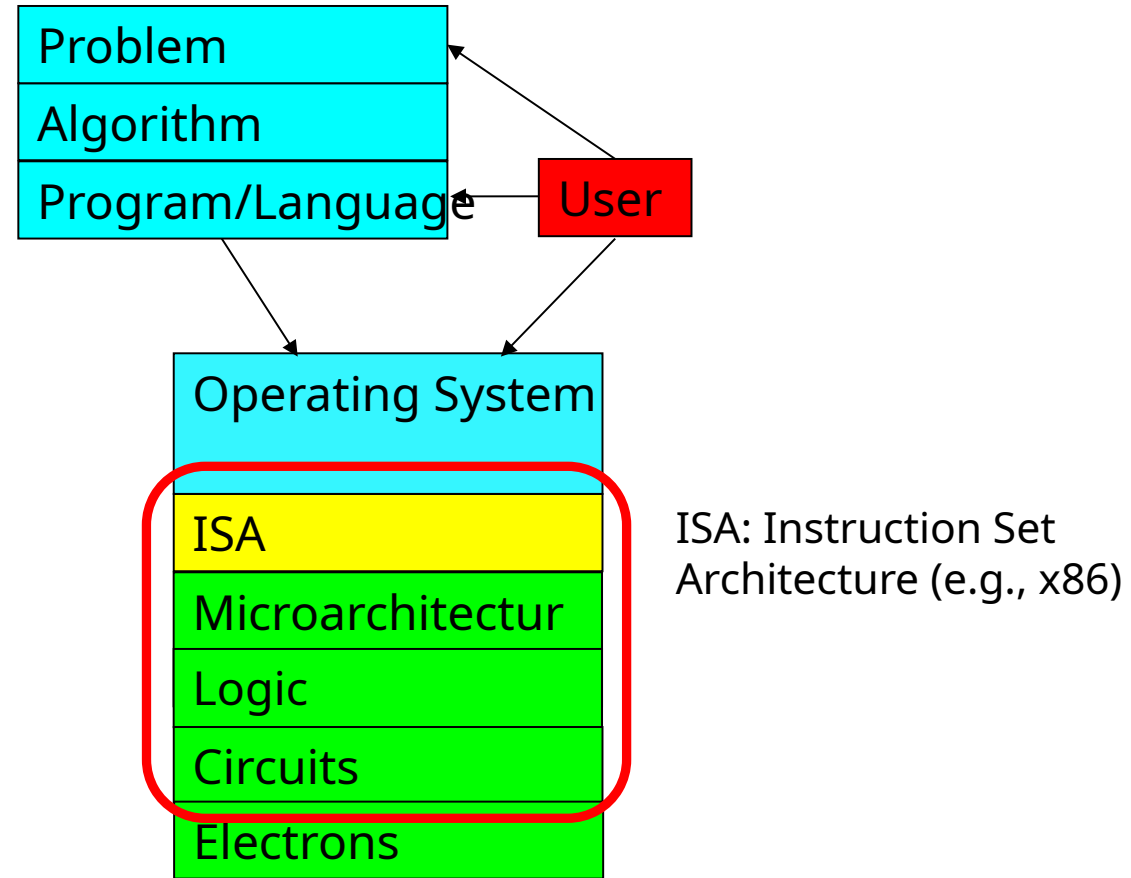
Write a program that does 'x' ..... using this:

Does it help if I tell you it is a multi-core system?



Tough, isn't it?  
We need something between  
you (user) and this chip

# Abstractions



\*Diagram credit: Prof. Onur Mutlu

# Transformations

Natural language  
Pseudocode

```
temp = v[k];  
v[k] = v[k+1];  
v[k+1] = temp;
```

```
ldr  r0, [r2]  
ldr  r1, [r2, #4]  
str  r1, [r2]  
str  r0, [r2, #4]
```

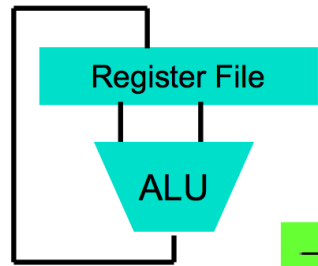
```
0000 1001 1100 0110 1010 1111 0101 1000  
1010 1111 0101 1000 0000 1001 1100 0110  
1100 0110 1010 1111 0101 1000 0000 1001  
0101 1000 0000 1001 1100 0110 1010 1111
```

Algorithm

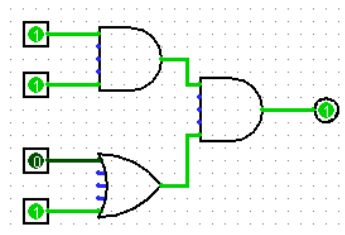
High-level programming language

Assembly language

Machine code



Components of the  
Architecture



Logic gates

*Architecture:*

**The art and science of  
designing structures.**

In this course, we will study the architecture of basic computing systems.

# What is a computer?

Any idea where the word “computer” comes from?



What is a computer?

Used to be “a person performing mathematical calculations”



Radhanath Sikdar (1813 -1870) - an Indian mathematician, an early “computer”.

The term "computer", in use from the early 17th century (the first known written reference dates from 1613), meant "one who computes": a person performing mathematical calculations.

What is a computer?

A calculating device?



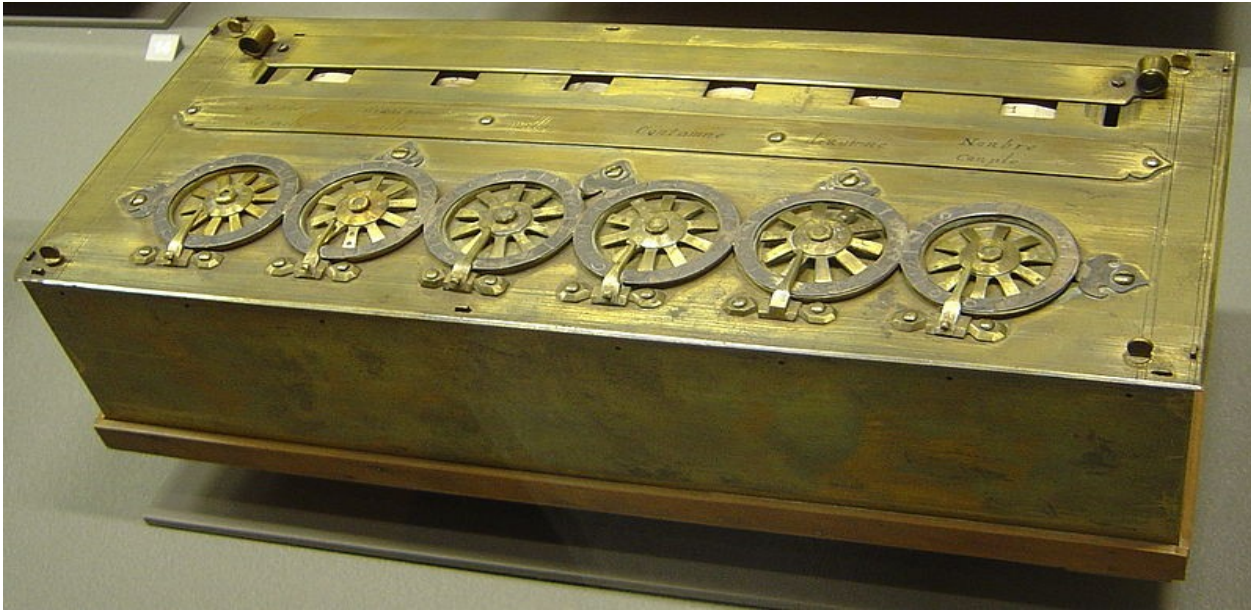
Reconstruction

The Antikythera Device (100BC)

An ancient analogue “computer” designed to calculate astronomical positions  
(video: <https://goo.gl/Lvh2St> and <https://www.youtube.com/watch?v=MghuAnySPZ0>)

What is a computer?

A device for numerical calculation?



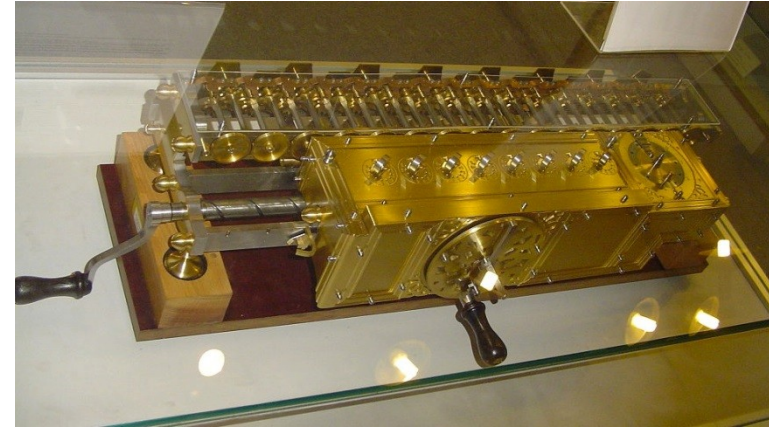
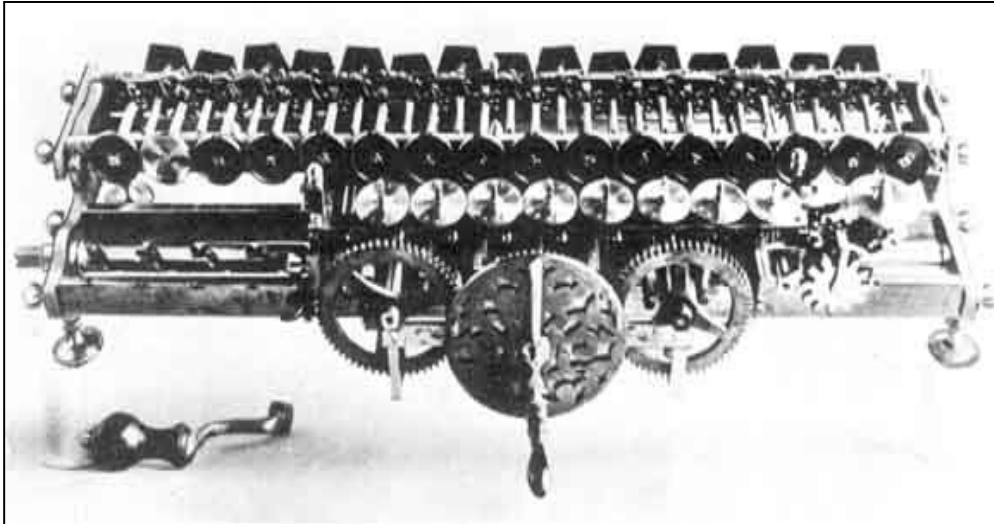
The “Pascaline”: 17th century (by Blaise Pascal)  
this calculating machine could **add and subtract** two numbers  
directly and **multiply and divide by repetition**.

<https://www.youtube.com/watch?v=3h71HAJWnVU>

Curiosity: in the 1970s, Niklaus Wirth  
named a programming language in  
homage to Blaise Pascal.

What is a computer?

A multi-purpose calculating device?



Replica of a late model

Leibniz' engine (aka Stepped Reckoner) –  
multiplication and division (end of 17th century) (  
<https://www.youtube.com/watch?v=aWDWiQHOCHw> )



# What is a computer?

A general purpose computing device?

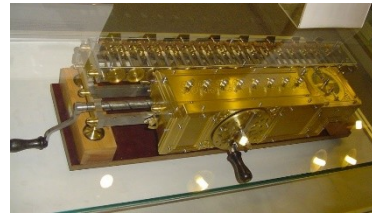
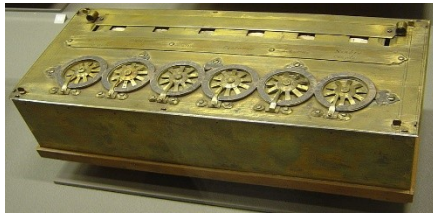


De Colmar's Arithmometer (1820) – 1<sup>st</sup> commercially successful mechanical calculator

Key player in the move from human computers to calculating machines that took place during the second half of the 19th century

See it in action: <http://www.youtube.com/watch?v=v6niUVf0dyQ>

What is a **modern** computer?



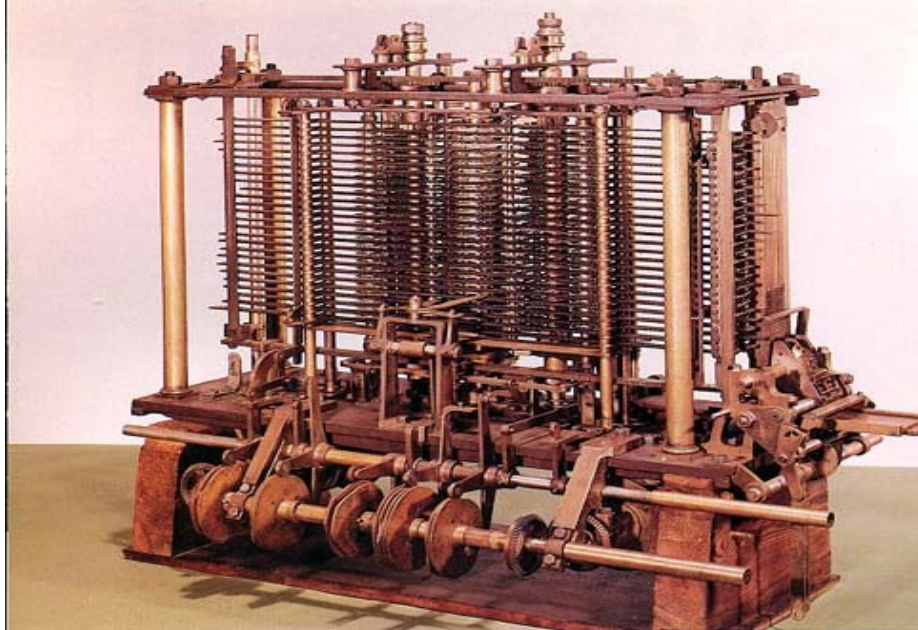
These devices were successful in aiding or replacing human computers.

However they are not consider computers in the modern use of the word.

So then what's consider the first modern computer?

What is a modern computer?

A **programmable** device?



## Charles Babbage's Analytical Engine (designed 1837)

First design of a **general-purpose programmable computer** that could be described in modern terms as Turing-complete (you'll learn in year 2 that it can be used to simulate a Turing-machine).

Babbage was never able to complete construction of any of his machines due to conflicts with his chief engineer and inadequate funding

Watch: <http://www.youtube.com/watch?v=QVxbNZWLP60> (from 3min32s)

Ada Lovelace - first world's programmer (Babbage's Analytical Engine)



<http://psychclassics.yorku.ca/Lovelace/menabrea.htm>

(1843: you can see the notes she wrote together with her translation of a talk given by Babbage)

Lovelace Colloquium:  
Encouraging Women in Software  
Usually around Easter time  
<https://bcswomenlovelace.bcs.org/>



London

The second Tuesday of every October marks  
Ada Lovelace Day



## Ada Lovelace - first world's programmer (Babbage's Analytical Engine)



<https://learningonscreen.ac.uk/ondemand/index.php/prog/0ADD2C3F?bcast=129909817>

# What is a computer?

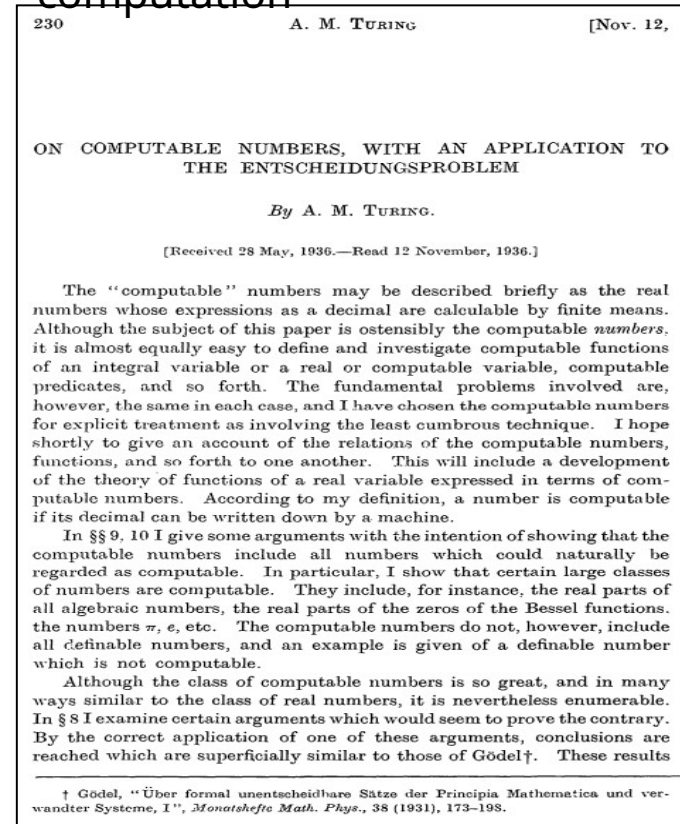
An abstract machine?

A set of instructions?



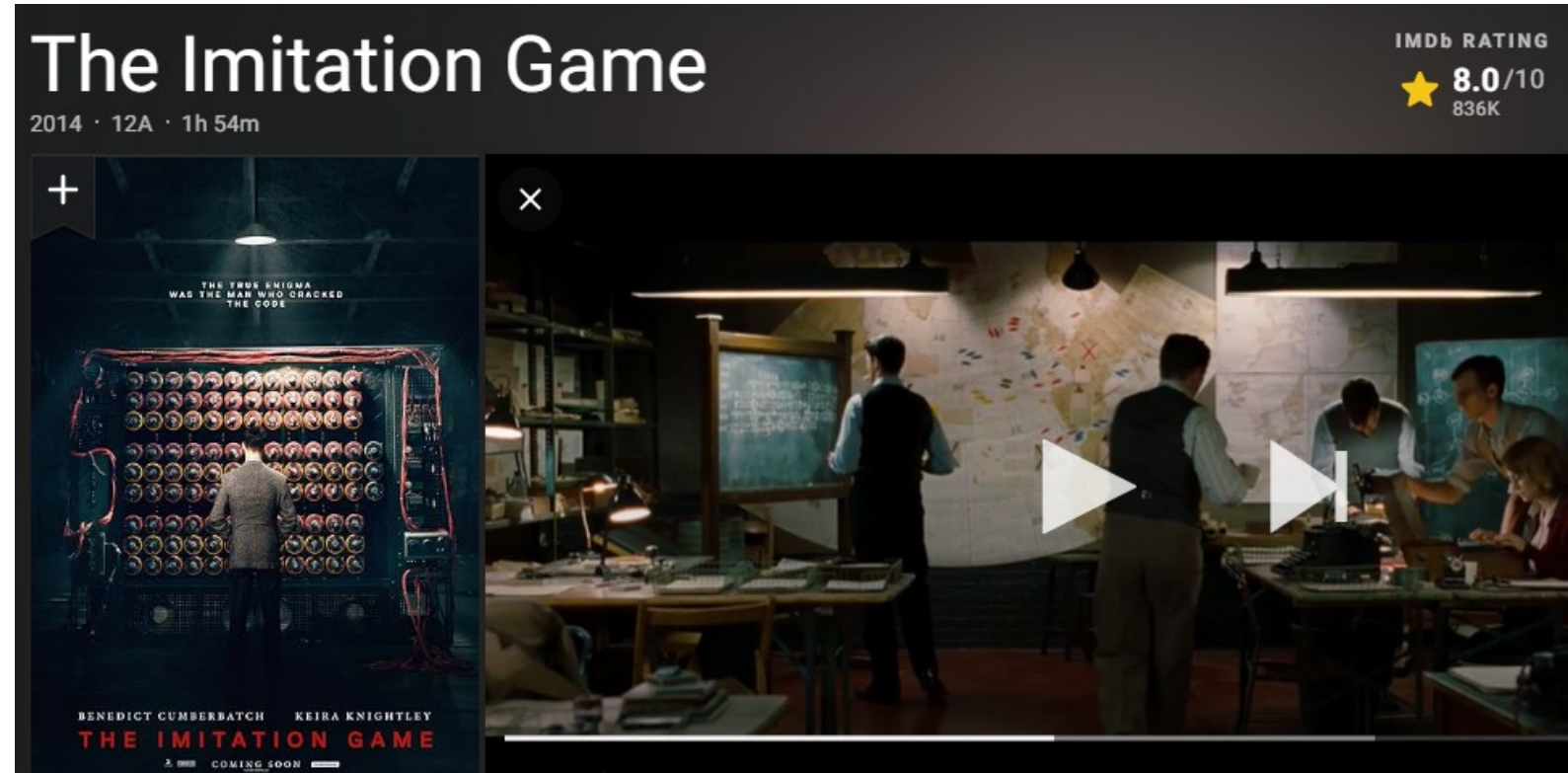
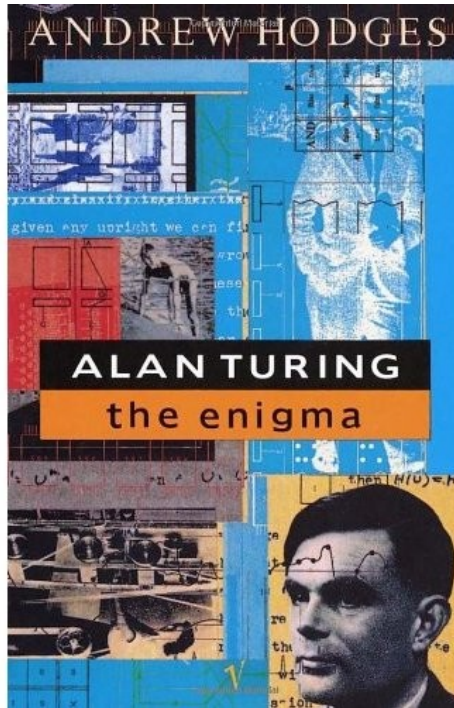
Alan Turing 1936

## Turing Machine – theory of computation



During World War II, Turing worked for the Government Code and Cypher School (GC&CS) at Bletchley Park, Britain's code breaking centre (e.g. Enigma machine)

# Alan Turing – book and film



## ACM Turing award

Considered by many the most prestigious award given in Computer Science

<https://youtu.be/NoypWbgKLt4>

The winners:

<http://amturing.acm.org/byyear.cfm>

Have a look at some of the winners  
(e.g. 2017, 2016; then 1997 and 1983)

To be continued...