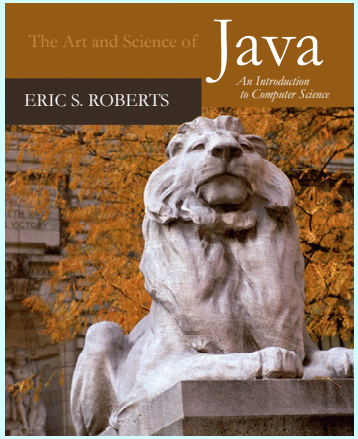
CHAPTER 1

Introduction

[The Analytical Engine offers] a new, a vast, and a powerful language . . . for the purposes of mankind.

—Augusta Ada Byron, Lady Lovelace, 1843



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1.4 Algorithms
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Computation involves 3 aspects:

1. A representation for data.
2. A set of operations (transformations) on the data.
3. An algorithm (sequence of operations) for realizing the computational problem.

examples →

Astronomical calculations: 150-100 BC

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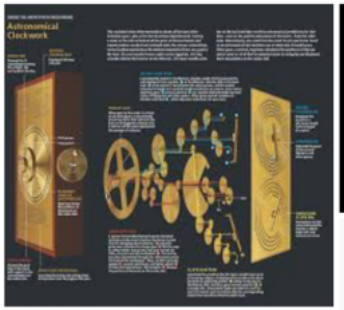
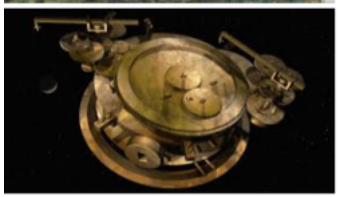
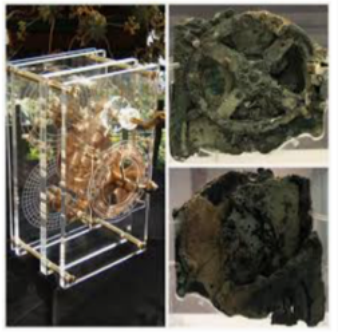
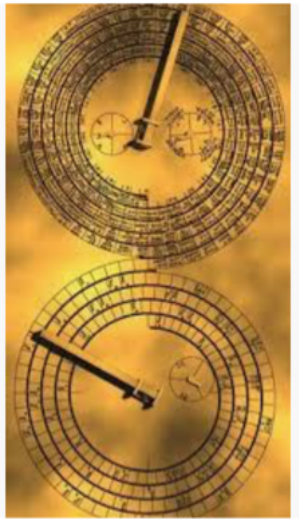
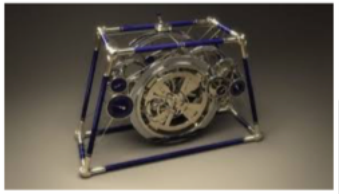
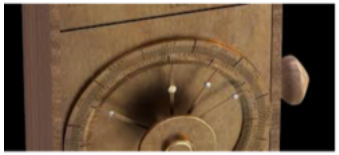


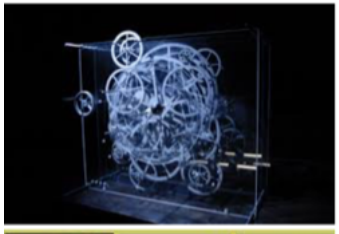
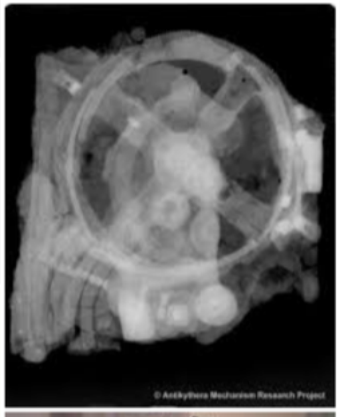



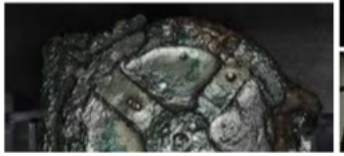





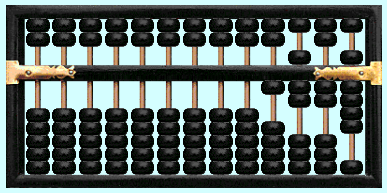






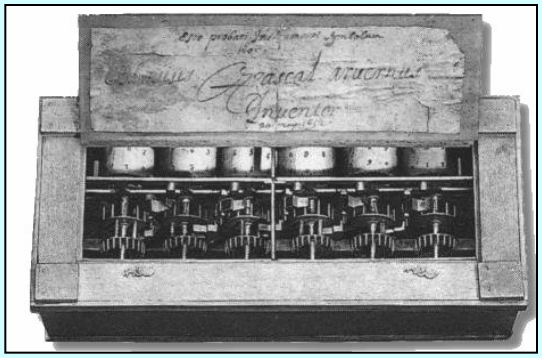
A Brief History of Computing

- Although electronic computers are relatively new, mechanical computers are much older. The abacus goes back almost 4000 years.

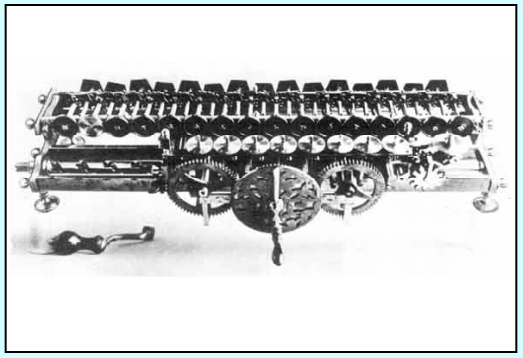


- In the 17th century, several mechanical computing devices were developed in Europe.

Reconstruction of 1623 Wilhelm Schickard machine (Deutsches Museum, Munich)



Blaise Pascal's 1641 "Pascaline" machine (Musée des Arts et Metiers, Paris)



Gottfried Wilhelm von Leibniz's calculating wheel (ca. 1671) (IBM)

- The most important conceptual breakthroughs, however, came in the early part of the 19th century . . .

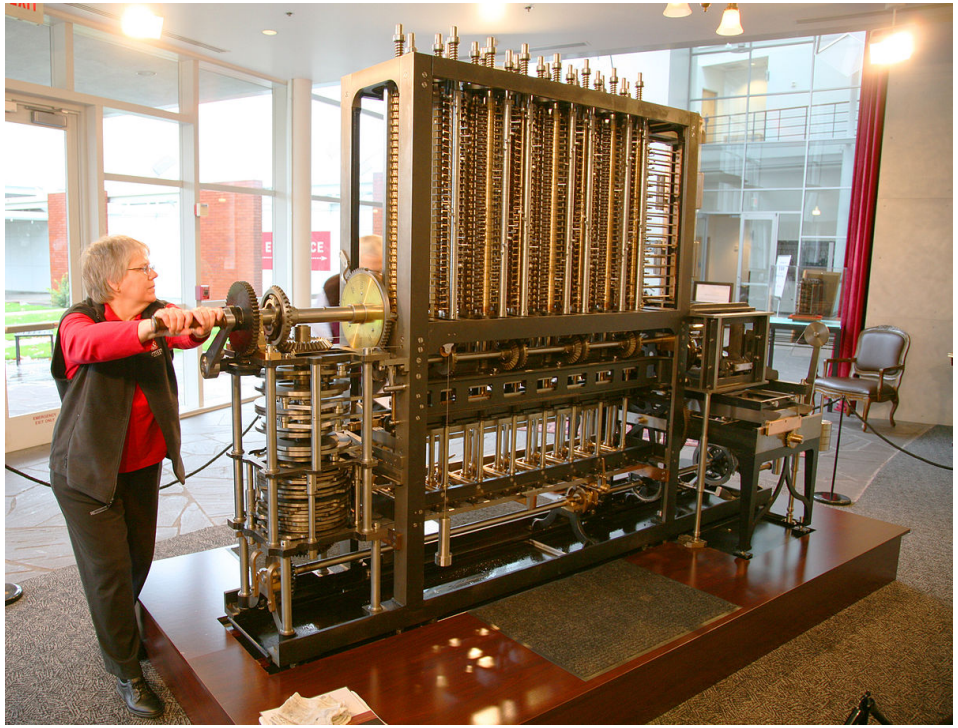
Babbage's Machines

Charles Babbage (1791-1871)

Charles Babbage is one of the most fascinating figures in the history of computing. Captivated by the idea that he could build a machine to produce mathematical tables, Babbage designed two machines, the **Difference Engine** and the **Analytical Engine**, that anticipated many of the features found in modern computers.

Although Babbage was unable to finish either machine during his lifetime, the Science Museum in London was able to complete a full-scale Difference Engine for the 200th anniversary of his birth.

Charles Babbage − Difference Engine #2



Evaluates a 7th order polynomial by the method of divided differences (Newton).

-holds eight 31-digit decimal numbers organized in columns.
-basic operations: addition, subtraction (using 10's complement).
-algorithm: compute difference of adjacent values stored in column to the left (discrete derivative).
-result: can evaluate polynomial of degree #columns-1 without use of multiplication.

-each iteration corresponds to turn of mechanical crank
-engine includes mechanical printer for direct production of tables
-sound design, but impossible to manufacture using Victorian machining technology.
-finally complete implementation in mid 90's completely validated Babbage's concepts.

Ada Byron, The First Programmer

Augusta Ada Byron,
Lady Lovelace (1815–1852)

Augusta Ada Byron, the daughter of English poet Lord Byron, was encouraged to pursue her interests in science and mathematics at a time when few women were allowed to study those subjects. At the age of 17, Ada met Charles Babbage and became fascinated by his machines. Ada was convinced of the potential of Babbage's Analytical Engine and wrote extensive notes on its design, along with several complex mathematical programs that have led many people to characterize her as the first programmer. In 1980, the U.S. Department of Defense named the programming language Ada in her honor.

The Birth of Modern Computing

- The question of who invented the modern computers is not an easy one, given the competing claims for that achievement.
- In 1939, John Atanasoff and Clifford Barry built a prototype computer at Iowa State and a large machine in 1942.
- The ~~first~~ Second large-scale computer was the Electronic Numerical Integrator and Computer (ENIAC), completed in 1946 under the direction of J. Presper Eckert and John Mauchly at the Moore School of the University of Pennsylvania. 17,468 vacuum tubes
- Conrad Zuse in Germany and the World War II cryptography team in England also built early computers.
- Other important contributions during the early years include stored-programming concept generally attributed to John von Neumann and the use of switching circuits to implement binary arithmetic proposed by Claude Shannon.

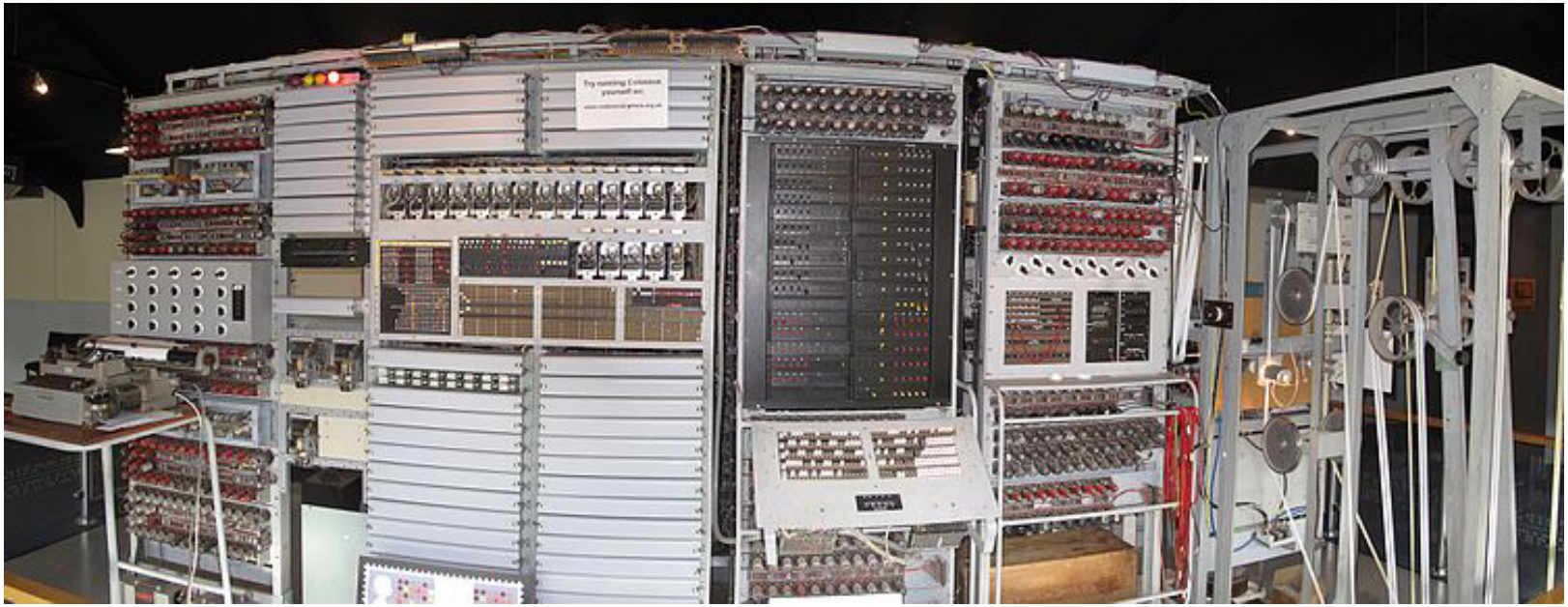
Electrical Engineer

Tommy Flowers

English engineer

Thomas Harold Flowers, MBE was an English engineer with the British Post Office. During World War II, Flowers designed and built Colossus, the world's first programmable electronic computer, to help solve encrypted German messages. Wikipedia

2500 vacuum tubes



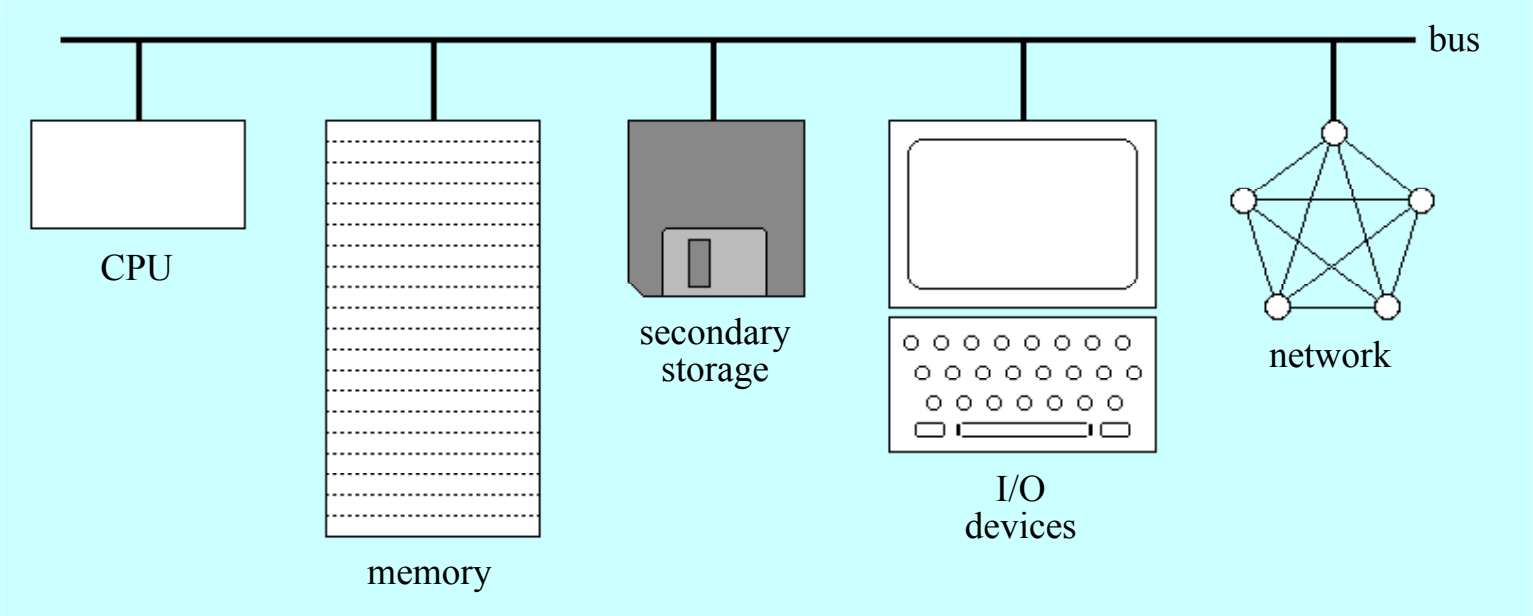
Colossus
c 1943

10 machines built

What is Computer Science?

- Many people imagine that *computer science* is the study of computers as artifacts and wonder how that can be a science.
- Computer science has more to do with the study of problem solving in which the solutions happen to use computers.
- Computer science draws on a range of intellectual traditions that includes aspects of mathematics, classical science, and engineering.
- Computer science plays an increasingly important role in other disciplines:
  - *Biology.* Computers made it possible to map the human genome.
  - *Economics.* Computers enable the creation of better economic models.
  - *Psychology.* Artificial intelligence helps us to understand the brain.
  - *Environment.* Climate models require modern computing technology.
  - *Literature.* Computerized analysis helps resolve disputed authorship.
  - *and most everything else . . .*

A Brief Tour of Computer Hardware



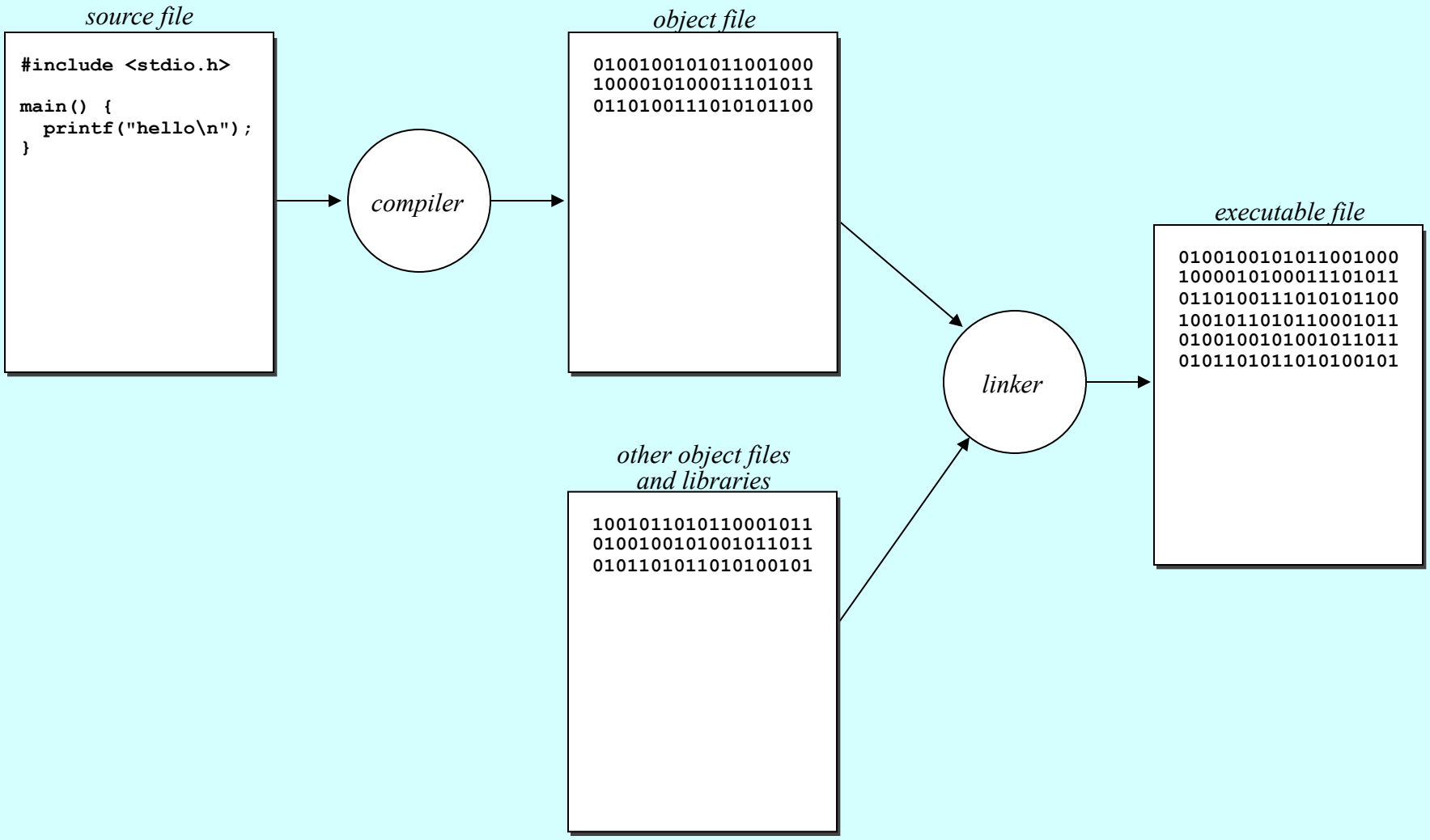
Algorithms

- Much of computer science involves the study of *algorithms*.
- In an informal sense, you can think of an algorithm as simply a procedure for solving a problem.
- To meet its more formal definition, an algorithm must be:
  - *Clearly and unambiguously defined.*
  - *Effective,* in the sense that its steps are executable.
  - *Finite,* in the sense that it terminates after a bounded number of steps.

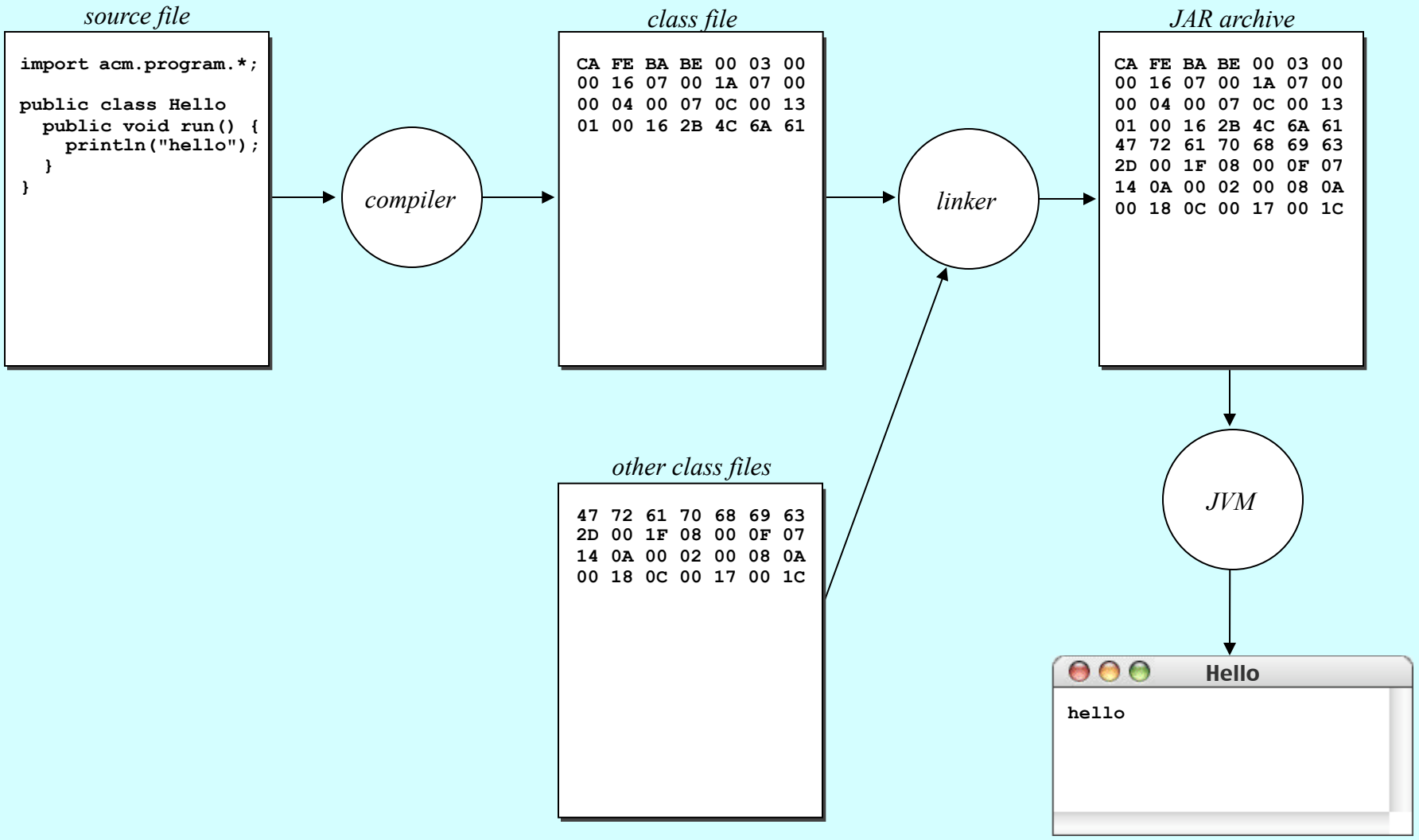
Stages in the Programming Process

- Each computer system understands a low-level language that is specific to that type of hardware, which is called its **machine language.**
- Programmers typically write their software in a **higher-level language** that is easier for humans to understand.
- To execute a programs written in a higher-level language, the computer must adopt one of two strategies:
  - The classical approach is to translate the higher-level language into machine language. This strategy is called **compilation.**
  - A second approach is to simulate the program operation without actually translating it to machine language. This strategy is called **interpretation.**
- Java uses a hybrid strategy:
  - Programs are compiled into an intermediate language that serves as the machine language for the **Java Virtual Machine** (**JVM**).
  - Java then interprets those programs by simulating the JVM.

The Compilation Process



The Java Interpreter



Java and the Object-Oriented Paradigm

- Programming languages typically support a particular style of use, which is called its **programming paradigm.**
- Traditional languages like FORTRAN, Pascal, and C use the **procedural paradigm,** in which the programmer defines the algorithmic operations and data structures independently.
- Modern languages like Java tend to favor the **object-oriented paradigm** in which the programmer defines the algorithmic and data structure of a program in a more integrated way.
- In Java, programs are written as collections of **classes,** which serve as templates for individual **objects.** Each object is an **instance** of a particular class; a single class can serve as a pattern for many different objects.

The End