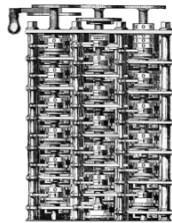# The Difference Engine

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The Difference Engine

Eric Roberts
CS 54N
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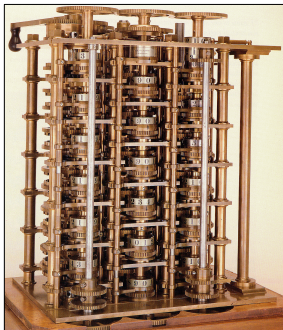
Babbage's Machines

**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 produce mathematical tables "by steam," Babbage designed two early computing machines—the **Difference Engine** and the vastly more powerful **Analytical Engine**—that anticipated many of the features found in modern computers.

Neither machine was completed within Babbage's lifetime. The Science Museum in London made a full-scale replica of the Difference Engine for the bicentennial of Babbage's birth in 1991.

The Difference Engine Prototype

Babbage completed a working model of his Difference Engine, which he had on display at his popular soirées in London.

The model on the left was given to the London Science Museum by Babbage's son.

Calculating with Differences

Suppose that you want to produce a table of squares:

0^2	1^2	2^2	3^2	4^2	5^2	6^2	7^2	8^2	9^2
0	1	4	9	16	25	36	49	64	81

first differences   1   3   5   7   9   11   13   15   17

second differences   2   2   2   2   2   2   2   2

Note that the second differences are constant.

Exercises for the Difference Engine

(a) How would you program the Difference Engine to produce a table of cubes:

0^3	1^3	2^3	3^3	4^3	5^3	6^3	7^3	8^3	9^3
0	1	8	27	64	125	216	343	512	729

(b) How would you program the Difference Engine to calculate the terms in the sequence generated by the following polynomial:

$$f(x) = x^2 - 5x + 10$$

Ada Byron, The First Programmer

**Augusta Ada Byron,
Lady Lovelace (1815–1852)**

Augusta Ada Byron, the daughter of the English poet Lord Byron and his wife Anne, 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.