German philosopher, professor of mathematics at the University of Jena (1879-1918). With George Boole, Frege was one of the founders of modern symbolic logic. In his *Foundations of Arithmetic* (1884), Frege attempted to derive all mathematics from logical axioms.

His first books describing this work were successful - and to some extent gratifyingly revolutionary in effect. His later development of this in a two-volume work, however, was over-ambitious and was accounted a failure, unfortunately discrediting much of his earlier and his later work. Nevertheless, his final system of logic is now accepted as one of the greatest contributions in the field put forward in the century surrounding it.

Frege was born on 8 November 1848 in Wismar, Germany, and grew up and received his early education there. He then spent two years 1869-71 as a student in Jena before transferring to Göttingen University, where he studied physics, chemistry, mathematics, and philosophy, earning his PhD in mathematics in 1873. The next year he entered the faculty of philosophy there.

Frege's studies over the following years were crystallized in a book he published in 1879 on a new symbolic mathematical language he had devised, which he called *Begriffschrift*. In that year he returned to Jena to take up a teaching post, and remained there for the rest of his working life. In 1884, Frege published another important book on the foundations of mathematics, and again relied upon his *Begriffschrift*. He attempted to develop his ideas still further in another, ill-fated, two-volume text, the first volume of which appeared in 1893, and the second in 1903. These volumes, entitled *Grundgesetze der Arithmetik*, received a severe blow when, shortly before the second volume was due to be published, Frege was sent a letter that demonstrated to him that the entire mathematical system described in the books was in fact of no value; nobly, he included a postscript to that effect in the second volume. After this personal disaster, Frege continued to study mathematics but never with the same scope or depth. He retired in 1917, still writing further material, extending some of his previous studies in the period 1918-23. He died in Bad Keinen, Germany, on 26 July 1925.

At the beginning of what was to become his life's work, Frege was correctly convinced that in terms of absolute precision ordinary language is not sufficiently strict for the expression of mathematical concepts such as the definition of number, object, and function. Furthermore, he saw that the symbols
already available to mathematicians were themselves not adequate for this purpose either, and so it would be necessary to create new ones - a vital step that mathematicians before him had resisted taking.

The resultant *Begriffsschrift* (which translates literally as ‘idea-script’) was intended as a method for the analysis and representation of mathematical proofs. It has since been developed into modern mathematical symbolic logic, and Frege is generally - and only reasonably - credited as its originator. He introduced the symbols for assertions, implications, and their converse notions; he also introduced propositional logic and quantification theory, inventing symbols for ‘and’, ‘or’, ‘if ..., then ...’, and so on. Using his new ‘language’ he was able succinctly and unambiguously to express complex logical relations, and even - when Frege applied it to the theory of sequences - to define the ancestral relation. This represented a major development in mathematical induction, and was later further explored by mathematicians such as Bertrand Russell and Alfred Whitehead in the UK.

Frege incorporated improvements to the *Begriffsschrift* into *Grundgesetze*, but was devastated to receive a letter from Bertrand Russell in 1902 - nine years after the appearance of the first volume - in which Russell asked Frege how his logical system coped with a particular logical paradox. To his chagrin, Frege’s system was not able to resolve it - and since the system had been intended to be complete and contradiction-free, he was forced to acknowledge his system to be useless.

Although at the time Frege was largely discredited, his work today is seen as of considerable importance. His innovations have been useful in the development of symbolic logic, and even the problem posed by Russell was resolved by later logico-mathematicians.

Frege, nevertheless, in many ways simply stopped at that point. Despite the fact that he carried on working, and for quite a number of years, developments in early 20th-century mathematics - such as Hilbert’s axiomatics - were apparently beyond Frege’s scope. He was unable to accept these new ideas, even when David Hilbert himself tried to clarify the issue for him. Frege was, therefore, a mathematician with the most ambitious plans for the development of a rigorous foundation for mathematics in which, in his own eyes, he did not succeed in his own lifetime.

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