Gottlob Frege

March 20, 2022

Contents

1 Gottlob Frege

German philosopher, logician, and mathematician (1848–1925) Not to be confused with Gottlob Frick[1].

Gottlob Frege

Frege in c. 1879

Born	8 November 1848
	Wismar, Grand Duchy of Mecklenburg-Schwerin, German Confederation
Died	26 July 1925 (aged 76)
	Bad Kleinen, Free State of Mecklenburg-Schwerin, German Reich
Education	University of Göttingen (PhD, 1873)
	University of Jena (Dr. phil. hab., 1874)
Notable work	*Begriffsschrift* (1879)
	The Foundations of Arithmetic (1884)
	Basic Laws of Arithmetic (1893–1903)
Era	19th-century philosophy
	20th-century philosophy
Region	Western philosophy
School	Analytic philosophy
	Linguistic turn
	Logical objectivism
	Modern Platonism[1]
	Logicism
	Transcendental idealism[2][3] (before 1891)
	Metaphysical realism[3] (after 1891)
	Foundationalism[4]
	Indirect realism[5]
	Redundancy theory of truth[6]

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1   https://en.wikipedia.org/wiki/Gottlob_Frick

Gottlob Frege

Institutions	University of Jena
Theses	*Ueber eine geometrische Darstellung der imaginären Gebilde in der Ebene (On a Geometrical Representation of Imaginary Forms in a Plane)* (1873) *Rechnungsmethoden, die sich auf eine Erweiterung des Größenbegriffes gründen (Methods of Calculation based on an Extension of the Concept of Magnitude)* (1874)
Doctoral advisor	Ernst Christian Julius Schering (PhD thesis advisor)
Other academic advisors	Rudolf Friedrich Alfred Clebsch
Notable students	Rudolf Carnap
Main interests	Philosophy of mathematics, mathematical logic, philosophy of language
Notable ideas	

Friedrich Ludwig Gottlob Frege (/ˈfreɪɡə/[2];[15] German: [ˈɡɔtloːp ˈfreːɡə][3]; 8 November 1848 – 26 July 1925) was a German philosopher[4], logician[5], and mathematician[6]. He worked as a mathematics professor at the University of Jena[7], and is understood by many to be the father of analytic philosophy[8], concentrating on the philosophy of language[9], logic[10],

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2   https://en.wikipedia.org/wiki/Help:IPA/English
3   https://en.wikipedia.org/wiki/Help:IPA/Standard_German
4   https://en.wikipedia.org/wiki/Philosopher
5   https://en.wikipedia.org/wiki/Mathematical_logic
6   https://en.wikipedia.org/wiki/Mathematician
7   https://en.wikipedia.org/wiki/University_of_Jena
8   https://en.wikipedia.org/wiki/Analytic_philosophy
9   https://en.wikipedia.org/wiki/Philosophy_of_language
10 https://en.wikipedia.org/wiki/Philosophy_of_logic

and mathematics[11]. Though he was largely ignored during his lifetime, Giuseppe Peano[12] (1858–1932), Bertrand Russell[13] (1872–1970), and, to some extent, Ludwig Wittgenstein[14] (1889–1951) introduced his work to later generations of philosophers. In the early 21st century, Frege was widely considered to be the greatest logician since Aristotle[15], and one of the most profound philosophers of mathematics ever.[16]

His contributions include the development of modern logic[16] in the *Begriffsschrift[17]* and work in the foundations of mathematics[18]. His book the *Foundations of Arithmetic[19]* is the seminal text of the logicist[20] project, and is cited by Michael Dummett[21] as where to pinpoint the linguistic turn[22]. His philosophical papers "On Sense and Reference[23]" and "The Thought" are also widely cited. The former argues for two different types of meaning[24] and descriptivism[25]. In *Foundations* and "The Thought", Frege argues for Platonism[26] against psychologism[27] or formalism[28], concerning numbers[29] and propositions[30] respectively. Russell's paradox[31] undermined the logicist project by showing Frege's Basic Law V[32] in the *Foundations* to be false.

1.1 Life

1.1.1 Childhood (1848–69)

Frege was born in 1848 in Wismar[33], Mecklenburg-Schwerin[34] (today part of Mecklenburg-Vorpommern[35]). His father Carl (Karl) Alexander Frege (1809–1866) was the co-founder and headmaster of a girls' high school until his death. After Carl's death, the school was led by Frege's mother Auguste Wilhelmine Sophie Frege (née Bialloblotzky, 12 January 1815 – 14 October 1898); her mother was Auguste Amalia Maria Ballhorn, a descendant of Philipp

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11 https://en.wikipedia.org/wiki/Philosophy_of_mathematics
12 https://en.wikipedia.org/wiki/Giuseppe_Peano
13 https://en.wikipedia.org/wiki/Bertrand_Russell
14 https://en.wikipedia.org/wiki/Ludwig_Wittgenstein
15 https://en.wikipedia.org/wiki/Aristotle
16 https://en.wikipedia.org/wiki/History_of_logic#Rise_of_modern_logic
17 https://en.wikipedia.org/wiki/Begriffsschrift
18 https://en.wikipedia.org/wiki/Foundations_of_mathematics
19 https://en.wikipedia.org/wiki/Foundations_of_Arithmetic
20 https://en.wikipedia.org/wiki/Logicist
21 https://en.wikipedia.org/wiki/Michael_Dummett
22 https://en.wikipedia.org/wiki/Linguistic_turn
23 https://en.wikipedia.org/wiki/On_Sense_and_Reference
24 https://en.wikipedia.org/wiki/Meaning_(philosophy_of_language)
25 https://en.wikipedia.org/wiki/Descriptivist_theory_of_names
26 https://en.wikipedia.org/wiki/Platonism
27 https://en.wikipedia.org/wiki/Psychologism
28 https://en.wikipedia.org/wiki/Formalism_(philosophy_of_mathematics)
29 https://en.wikipedia.org/wiki/Number
30 https://en.wikipedia.org/wiki/Proposition
31 https://en.wikipedia.org/wiki/Russell%27s_paradox
32 https://en.wikipedia.org/wiki/Basic_Law_V
33 https://en.wikipedia.org/wiki/Wismar
34 https://en.wikipedia.org/wiki/Grand_Duchy_of_Mecklenburg-Schwerin
35 https://en.wikipedia.org/wiki/Mecklenburg-Vorpommern

Melanchthon[36][17] and her father was Johann Heinrich Siegfried Bialloblotzky, a descendant of a Polish[37] noble family who left Poland in the 17th century.[18]

In childhood, Frege encountered philosophies that would guide his future scientific career. For example, his father wrote a textbook[38] on the German language for children aged 9–13, entitled *Hülfsbuch zum Unterrichte in der deutschen Sprache für Kinder von 9 bis 13 Jahren* (2nd ed., Wismar 1850; 3rd ed., Wismar and Ludwigslust: Hinstorff, 1862) (Help book for teaching German to children from 9 to 13 years old), the first section of which dealt with the structure and logic[39] of language[40].

Frege studied at Große Stadtschule Wismar[41] and graduated in 1869.[19] His teacher Gustav Adolf Leo Sachse (5 November 1843 – 1 September 1909), who was a poet, played the most important role in determining Frege's future scientific career, encouraging him to continue his studies at the University of Jena[42].

1.1.2 Studies at University (1869–74)

Frege matriculated at the University of Jena in the spring of 1869 as a citizen of the North German Confederation[43]. In the four semesters of his studies he attended approximately twenty courses of lectures, most of them on mathematics and physics. His most important teacher was Ernst Karl Abbe[44] (1840–1905; physicist, mathematician, and inventor). Abbe gave lectures on theory of gravity, galvanism and electrodynamics, complex analysis theory of functions of a complex variable, applications of physics, selected divisions of mechanics, and mechanics of solids. Abbe was more than a teacher to Frege: he was a trusted friend, and, as director of the optical manufacturer Carl Zeiss AG, he was in a position to advance Frege's career. After Frege's graduation, they came into closer correspondence.

His other notable university teachers were Christian Philipp Karl Snell (1806–86; subjects: use of infinitesimal analysis in geometry, analytic geometry[45] of planes[46], analytical mechanics, optics, physical foundations of mechanics); Hermann Karl Julius Traugott Schaeffer[47] (1824–1900; analytic geometry, applied physics, algebraic analysis, on the telegraph and other electronic machines[48]); and the philosopher Kuno Fischer[49] (1824–1907; Kantian[50] and critical philosophy[51]).

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36 https://en.wikipedia.org/wiki/Philipp_Melanchthon
37 https://en.wikipedia.org/wiki/Poles
38 https://en.wikipedia.org/wiki/Textbook
39 https://en.wikipedia.org/wiki/Logic
40 https://en.wikipedia.org/wiki/Language
41 https://en.wikipedia.org/w/index.php?title=Gro%C3%9Fe_Stadtschule_Wismar&action=edit&redlink=1
42 https://en.wikipedia.org/wiki/University_of_Jena
43 https://en.wikipedia.org/wiki/North_German_Confederation
44 https://en.wikipedia.org/wiki/Ernst_Karl_Abbe
45 https://en.wikipedia.org/wiki/Analytic_geometry
46 https://en.wikipedia.org/wiki/Plane_(geometry)
47 https://en.wikipedia.org/w/index.php?title=Hermann_Schaeffer&action=edit&redlink=1
48 https://en.wikipedia.org/wiki/Electronics
49 https://en.wikipedia.org/wiki/Kuno_Fischer
50 https://en.wikipedia.org/wiki/Kantianism
51 https://en.wikipedia.org/wiki/Critical_philosophy

Starting in 1871, Frege continued his studies in Göttingen, the leading university in mathematics in German-speaking territories, where he attended the lectures of Rudolf Friedrich Alfred Clebsch[52] (1833–72; analytic geometry), Ernst Christian Julius Schering[53] (1824–97; function theory), Wilhelm Eduard Weber[54] (1804–91; physical studies, applied physics), Eduard Riecke (1845–1915; theory of electricity), and Hermann Lotze[55] (1817–81; philosophy of religion). Many of the philosophical doctrines of the mature Frege have parallels in Lotze; it has been the subject of scholarly debate whether or not there was a direct influence on Frege's views arising from his attending Lotze's lectures.

In 1873, Frege attained his doctorate under Ernst Christian Julius Schering, with a dissertation under the title of "Ueber eine geometrische Darstellung der imaginären Gebilde in der Ebene" ("On a Geometrical Representation of Imaginary Forms in a Plane"), in which he aimed to solve such fundamental problems in geometry as the mathematical interpretation of projective geometry[56]'s infinitely distant (imaginary) points.

Frege married Margarete Katharina Sophia Anna Lieseberg (15 February 1856 – 25 June 1904) on 14 March 1887.[19]

1.2 Work as a logician

Main article: Begriffsschrift[57] Though his education and early mathematical work focused primarily on geometry, Frege's work soon turned to logic. His
Begriffsschrift, eine der arithmetischen nachgebildete Formelsprache des reinen Denkens[58] [
Concept-Script: A Formal Language for Pure Thought Modeled on that of Arithmetic], Halle a/S: Verlag von Louis Nebert, 1879 marked a turning point in the history of logic. The *Begriffsschrift* broke new ground, including a rigorous treatment of the ideas of functions[59] and variables[60]. Frege's goal was to show that mathematics grows out of logic[61], and in so doing, he devised techniques that separated him from the Aristotelian syllogistic but took him rather close to Stoic propositional logic.[20]

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52 https://en.wikipedia.org/wiki/Alfred_Clebsch
53 https://en.wikipedia.org/wiki/Ernst_Christian_Julius_Schering
54 https://en.wikipedia.org/wiki/Wilhelm_Eduard_Weber
55 https://en.wikipedia.org/wiki/Hermann_Lotze
56 https://en.wikipedia.org/wiki/Projective_geometry
57 https://en.wikipedia.org/wiki/Begriffsschrift
58 https://en.wikipedia.org/wiki/Begriffsschrift
59 https://en.wikipedia.org/wiki/Function_(mathematics)
60 https://en.wikipedia.org/wiki/Variable_(mathematics)
61 https://en.wikipedia.org/wiki/Logic

Figure 1 Title page to *Begriffsschrift* (1879)

In effect, Frege invented axiomatic[62] predicate logic[63], in large part thanks to his invention of quantified variables[64], which eventually became ubiquitous in mathematics[65] and logic, and which solved the problem of multiple generality[66]. Previous logic had dealt with the logical constants[67] *and*, *or*, *if... then...*, *not*, and *some* and *all*, but iterations of these operations,

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62 https://en.wikipedia.org/wiki/Axiomatization
63 https://en.wikipedia.org/wiki/Predicate_logic
64 https://en.wikipedia.org/wiki/Quantification_(logic)
65 https://en.wikipedia.org/wiki/Mathematics
66 https://en.wikipedia.org/wiki/Problem_of_multiple_generality
67 https://en.wikipedia.org/wiki/Logical_constant

especially "some" and "all", were little understood: even the distinction between a sentence like "every boy loves some girl" and "some girl is loved by every boy" could be represented only very artificially, whereas Frege's formalism had no difficulty expressing the different readings of "every boy loves some girl who loves some boy who loves some girl" and similar sentences, in complete parallel with his treatment of, say, "every boy is foolish".

A frequently noted example is that Aristotle's logic is unable to represent mathematical statements like Euclid's theorem[68], a fundamental statement of number theory that there are an infinite number of prime numbers[69]. Frege's "conceptual notation", however, can represent such inferences.[21] The analysis of logical concepts and the machinery of formalization that is essential to *Principia Mathematica*[70] (3 vols., 1910–13, by Bertrand Russell[71], 1872–1970, and Alfred North Whitehead[72], 1861–1947), to Russell's theory of descriptions[73], to Kurt Gödel[74]'s (1906–78) incompleteness theorems[75], and to Alfred Tarski[76]'s (1901–83) theory of truth, is ultimately due to Frege.

One of Frege's stated purposes was to isolate genuinely logical principles of inference, so that in the proper representation of mathematical proof, one would at no point appeal to "intuition". If there was an intuitive element, it was to be isolated and represented separately as an axiom: from there on, the proof was to be purely logical and without gaps. Having exhibited this possibility, Frege's larger purpose was to defend the view that arithmetic[77] is a branch of logic, a view known as logicism[78]: unlike geometry, arithmetic was to be shown to have no basis in "intuition", and no need for non-logical axioms. Already in the 1879 *Begriffsschrift* important preliminary theorems, for example, a generalized form of law of trichotomy[79], were derived within what Frege understood to be pure logic.

This idea was formulated in non-symbolic terms in his *The Foundations of Arithmetic*[80] (*Die Grundlagen der Arithmetik*, 1884). Later, in his *Basic Laws of Arithmetic* (*Grundgesetze der Arithmetik*, vol. 1, 1893; vol. 2, 1903; vol. 2 was published at his own expense), Frege attempted to derive, by use of his symbolism, all of the laws of arithmetic from axioms he asserted as logical. Most of these axioms were carried over from his *Begriffsschrift*[81], though not without some significant changes. The one truly new principle was one he called the Basic Law V[82]: the "value-range" of the function $f(x)$ is the same as the "value-range" of the function $g(x)$ if and only if $\forall x[f(x) = g(x)]$.

68   https://en.wikipedia.org/wiki/Euclid%27s_theorem
69   https://en.wikipedia.org/wiki/Prime_number
70   https://en.wikipedia.org/wiki/Principia_Mathematica
71   https://en.wikipedia.org/wiki/Bertrand_Russell
72   https://en.wikipedia.org/wiki/Alfred_North_Whitehead
73   https://en.wikipedia.org/wiki/Theory_of_descriptions
74   https://en.wikipedia.org/wiki/Kurt_G%C3%B6del
75   https://en.wikipedia.org/wiki/G%C3%B6del%27s_incompleteness_theorem
76   https://en.wikipedia.org/wiki/Alfred_Tarski
77   https://en.wikipedia.org/wiki/Arithmetic
78   https://en.wikipedia.org/wiki/Logicism
79   https://en.wikipedia.org/wiki/Law_of_trichotomy
80   https://en.wikipedia.org/wiki/The_Foundations_of_Arithmetic
81   https://en.wikipedia.org/wiki/Begriffsschrift
82   https://en.wikipedia.org/wiki/Basic_Law_V

The crucial case of the law may be formulated in modern notation as follows. Let $\{x|Fx\}$ denote the extension[83] of the predicate[84] Fx, that is, the set of all Fs, and similarly for Gx. Then Basic Law V says that the predicates Fx and Gx have the same extension if and only if[85] $\forall x[Fx \leftrightarrow Gx]$. The set of Fs is the same as the set of Gs just in case every F is a G and every G is an F. (The case is special because what is here being called the extension of a predicate, or a set, is only one type of "value-range" of a function.)

In a famous episode, Bertrand Russell wrote to Frege, just as Vol. 2 of the *Grundgesetze* was about to go to press in 1903, showing that Russell's paradox[86] could be derived from Frege's Basic Law V. It is easy to define the relation of *membership* of a set or extension in Frege's system; Russell then drew attention to "the set of things x that are such that x is not a member of x". The system of the *Grundgesetze* entails that the set thus characterised *both* is *and* is not a member of itself, and is thus inconsistent. Frege wrote a hasty, last-minute Appendix to Vol. 2, deriving the contradiction and proposing to eliminate it by modifying Basic Law V. Frege opened the Appendix with the exceptionally honest comment: "Hardly anything more unfortunate can befall a scientific writer than to have one of the foundations of his edifice shaken after the work is finished. This was the position I was placed in by a letter of Mr. Bertrand Russell, just when the printing of this volume was nearing its completion." (This letter and Frege's reply are translated in Jean van Heijenoort[87] 1967.)

Frege's proposed remedy was subsequently shown to imply that there is but one object in the universe of discourse[88], and hence is worthless (indeed, this would make for a contradiction in Frege's system if he had axiomatized the idea, fundamental to his discussion, that the True and the False are distinct objects; see, for example, Dummett[89] 1973), but recent work has shown that much of the program of the *Grundgesetze* might be salvaged in other ways:

- Basic Law V can be weakened in other ways. The best-known way is due to philosopher and mathematical logician George Boolos[90] (1940–1996), who was an expert on the work of Frege. A "concept" F is "small" if the objects falling under F cannot be put into one-to-one correspondence with the universe of discourse, that is, unless: $\exists R[R$ is 1-to-1 & $\forall x \exists y(xRy$ & $Fy)]$. Now weaken V to V*: a "concept" F and a "concept" G have the same "extension" if and only if neither F nor G is small or $\forall x(Fx \leftrightarrow Gx)$. V* is consistent if second-order arithmetic[91] is, and suffices to prove the axioms of second-order arithmetic.
- Basic Law V can simply be replaced with Hume's principle[92], which says that the number of Fs is the same as the number of Gs if and only if the Fs can be put into a one-to-one correspondence with the Gs. This principle, too, is consistent if second-order arithmetic is, and suffices to prove the axioms of second-order arithmetic. This result is termed Frege's theorem[93] because it was noticed that in developing arithmetic, Frege's use of Basic Law V is restricted to a proof of Hume's principle; it is from this, in turn, that

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83 https://en.wikipedia.org/wiki/Extension_(predicate_logic)
84 https://en.wikipedia.org/wiki/Predicate_(logic)
85 https://en.wikipedia.org/wiki/If_and_only_if
86 https://en.wikipedia.org/wiki/Russell%27s_paradox
87 https://en.wikipedia.org/wiki/Jean_van_Heijenoort
88 https://en.wikipedia.org/wiki/Universe_of_discourse
89 https://en.wikipedia.org/wiki/Michael_Dummett
90 https://en.wikipedia.org/wiki/George_Boolos
91 https://en.wikipedia.org/wiki/Second-order_arithmetic
92 https://en.wikipedia.org/wiki/Hume%27s_principle
93 https://en.wikipedia.org/wiki/Frege%27s_theorem

arithmetical principles are derived. On Hume's principle and Frege's theorem, see "Frege's Logic, Theorem, and Foundations for Arithmetic".[22]

- Frege's logic, now known as second-order logic[94], can be weakened to so-called predicative[95] second-order logic. Predicative second-order logic plus Basic Law V is provably consistent by finitistic[96] or constructive[97] methods, but it can interpret only very weak fragments of arithmetic.[23]

Frege's work in logic had little international attention until 1903 when Russell wrote an appendix to *The Principles of Mathematics*[98] stating his differences with Frege. The diagrammatic notation that Frege used had no antecedents (and has had no imitators since). Moreover, until Russell and Whitehead's *Principia Mathematica*[99] (3 vols.) appeared in 1910–13, the dominant approach to mathematical logic[100] was still that of George Boole[101] (1815–64) and his intellectual descendants, especially Ernst Schröder[102] (1841–1902). Frege's logical ideas nevertheless spread through the writings of his student Rudolf Carnap[103] (1891–1970) and other admirers, particularly Bertrand Russell and Ludwig Wittgenstein[104] (1889–1951).

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94 https://en.wikipedia.org/wiki/Second-order_logic
95 https://en.wikipedia.org/wiki/Impredicativity
96 https://en.wikipedia.org/wiki/Finitism
97 https://en.wikipedia.org/wiki/Mathematical_constructivism
98 https://en.wikipedia.org/wiki/The_Principles_of_Mathematics
99 https://en.wikipedia.org/wiki/Principia_Mathematica
100 https://en.wikipedia.org/wiki/Mathematical_logic
101 https://en.wikipedia.org/wiki/George_Boole
102 https://en.wikipedia.org/wiki/Ernst_Schr%C3%B6der_(mathematician)
103 https://en.wikipedia.org/wiki/Rudolf_Carnap
104 https://en.wikipedia.org/wiki/Ludwig_Wittgenstein

1.3 Philosopher
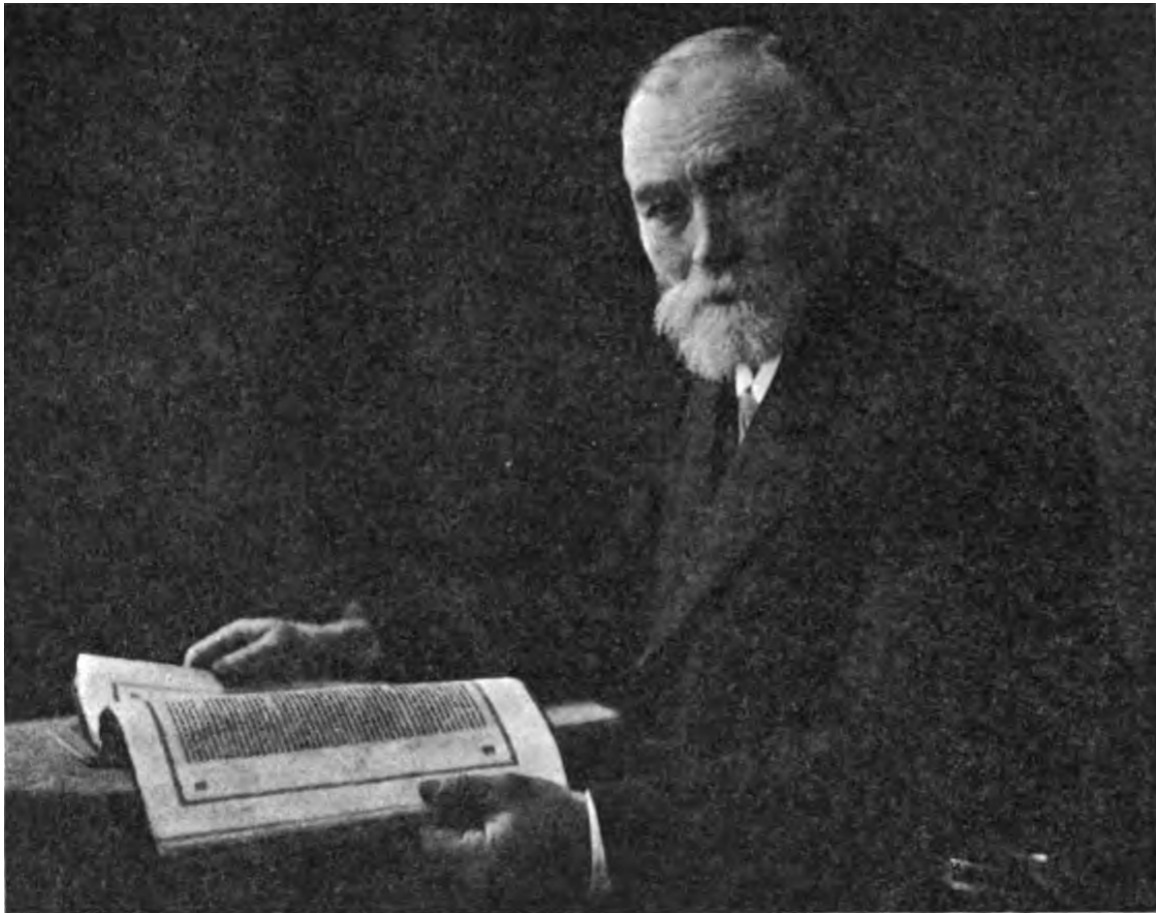
Figure 2 Frege, c. 1905

Frege is one of the founders of analytic philosophy[105], whose work on logic and language gave rise to the linguistic turn[106] in philosophy. His contributions to the philosophy of language[107] include:

- Function[108] and argument analysis of the proposition[109];
- Distinction between concept and object[110] (*Begriff und Gegenstand*);
- Principle of compositionality[111];
- Context principle[112]; and

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105 https://en.wikipedia.org/wiki/Analytic_philosophy

106 https://en.wikipedia.org/wiki/Linguistic_turn

107 https://en.wikipedia.org/wiki/Philosophy_of_language

108 https://en.wikipedia.org/wiki/Function_(mathematics)

109 https://en.wikipedia.org/wiki/Proposition

110 https://en.wikipedia.org/wiki/Concept_and_object

111 https://en.wikipedia.org/wiki/Compositionality

112 https://en.wikipedia.org/wiki/Context_principle

- Distinction between the sense and reference[113] (*Sinn und Bedeutung*) of names and other expressions, sometimes said to involve a mediated reference theory[114].

As a philosopher of mathematics, Frege attacked the psychologistic[115] appeal to mental explanations of the content of judgment of the meaning of sentences. His original purpose was very far from answering general questions about meaning; instead, he devised his logic to explore the foundations of arithmetic, undertaking to answer questions such as "What is a number?" or "What objects do number-words ('one', 'two', etc.) refer to?" But in pursuing these matters, he eventually found himself analysing and explaining what meaning is, and thus came to several conclusions that proved highly consequential for the subsequent course of analytic philosophy and the philosophy of language.

1.4 Sense and reference

Main article: Sense and reference[116] Frege's 1892 paper, "On Sense and Reference[117]" ("Über Sinn und Bedeutung"), introduced his influential distinction between *sense* ("Sinn") and *reference* ("Bedeutung", which has also been translated as "meaning", or "denotation"). While conventional accounts of meaning took expressions to have just one feature (reference), Frege introduced the view that expressions have two different aspects of significance: their sense and their reference.

Reference (or "Bedeutung") applied to proper names[118], where a given expression (say the expression "Tom") simply refers to the entity bearing the name (the person named Tom). Frege also held that propositions had a referential relationship with their truth-value (in other words, a statement "refers" to the truth-value it takes). By contrast, the *sense* (or "Sinn") associated with a complete sentence is the thought it expresses. The sense of an expression is said to be the "mode of presentation" of the item referred to, and there can be multiple modes of representation for the same referent.

The distinction can be illustrated thus: In their ordinary uses, the name "Charles Philip Arthur George Mountbatten-Windsor", which for logical purposes is an unanalyzable whole, and the functional expression "the Prince of Wales", which contains the significant parts "the prince of ξ" and "Wales", have the same *reference*, namely, the person best known as Prince Charles. But the *sense* of the word "Wales" is a part of the sense of the latter expression, but no part of the sense of the "full name" of Prince Charles.

These distinctions were disputed by Bertrand Russell, especially in his paper "On Denoting[119]"; the controversy has continued into the present, fueled especially by Saul Kripke[120]'s famous lectures "Naming and Necessity[121]".

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113 https://en.wikipedia.org/wiki/Sense_and_reference
114 https://en.wikipedia.org/wiki/Mediated_reference_theory
115 https://en.wikipedia.org/wiki/Psychologism
116 https://en.wikipedia.org/wiki/Sense_and_reference
117 https://en.wikipedia.org/wiki/On_Sense_and_Reference
118 https://en.wikipedia.org/wiki/Proper_names
119 https://en.wikipedia.org/wiki/On_Denoting
120 https://en.wikipedia.org/wiki/Saul_Kripke
121 https://en.wikipedia.org/wiki/Naming_and_Necessity

1.5 1924 diary

Frege's published philosophical writings were of a very technical nature and divorced from practical issues, so much so that Frege scholar Dummett[122] expressed his "shock to discover, while reading Frege's diary, that his hero was an anti-Semite."[24] After the German Revolution of 1918–19[123] his political opinions became more radical. In the last year of his life, at the age of 76, his diary contained political opinions opposing the parliamentary system, democrats, liberals, Catholics, the French and Jews, who he thought ought to be deprived of political rights and, preferably, expelled from Germany.[25] Frege confided "that he had once thought of himself as a liberal and was an admirer of Bismarck[124]", but then sympathized with General Ludendorff[125]. Some interpretations have been written about that time.[26] The diary contains a critique of universal suffrage[126] and socialism. Frege had friendly relations with Jews in real life: among his students was Gershom Scholem[127],[27][28] who greatly valued his teaching, and it was he who encouraged Ludwig Wittgenstein[128] to leave for England in order to study with Bertrand Russell[129].[29] The 1924 diary was published posthumously in 1994.[30] Frege apparently never spoke in public about his political viewpoints.

1.6 Personality

Frege was described by his students as a highly introverted person, seldom entering into dialogues with others and mostly facing the blackboard while lecturing. He was, however, known to occasionally show wit and even bitter sarcasm during his classes.[31]

1.7 Important dates

- Born 8 November 1848 in Wismar[130], Mecklenburg-Schwerin[131].
- 1869 — attends the University of Jena[132].
- 1871 — attends the University of Göttingen[133].
- 1873 — PhD, doctor in mathematics[134] (geometry[135]), attained at Göttingen.
- 1874 — Habilitation[136] at Jena; private teacher[137].

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122 https://en.wikipedia.org/wiki/Michael_Dummett
123 https://en.wikipedia.org/wiki/German_Revolution_of_1918%E2%80%9319
124 https://en.wikipedia.org/wiki/Otto_von_Bismarck
125 https://en.wikipedia.org/wiki/Erich_Ludendorff
126 https://en.wikipedia.org/wiki/Universal_suffrage
127 https://en.wikipedia.org/wiki/Gershom_Scholem
128 https://en.wikipedia.org/wiki/Ludwig_Wittgenstein
129 https://en.wikipedia.org/wiki/Bertrand_Russell
130 https://en.wikipedia.org/wiki/Wismar
131 https://en.wikipedia.org/wiki/Grand_Duchy_of_Mecklenburg-Schwerin
132 https://en.wikipedia.org/wiki/University_of_Jena
133 https://en.wikipedia.org/wiki/University_of_G%C3%B6ttingen
134 https://en.wikipedia.org/wiki/Mathematics
135 https://en.wikipedia.org/wiki/Geometry
136 https://en.wikipedia.org/wiki/Habilitation
137 https://en.wikipedia.org/wiki/Privatdozent

- 1879 — Ausserordentlicher Professor[138] at Jena.
- 1896 — Ordentlicher Honorarprofessor[139] at Jena.
- 1918 — retires.[32]
- Died 26 July 1925 in Bad Kleinen[140] (now part of Mecklenburg-Vorpommern[141]).

1.8 Important works

1.8.1 Logic, foundation of arithmetic

Begriffsschrift: eine der arithmetischen nachgebildete Formelsprache des reinen Denkens[142] (1879), Halle an der Saale: Verlag von Louis Nebert (online version[143]).

- In English: *Begriffsschrift, a Formula Language, Modeled Upon That of Arithmetic, for Pure Thought*, in: J. van Heijenoort[144] (ed.), *From Frege to Gödel: A Source Book in Mathematical Logic, 1879-1931*, Harvard, MA: Harvard University Press, 1967, pp. 5–82.
- In English (selected sections revised in modern formal notation): R. L. Mendelsohn, *The Philosophy of Gottlob Frege*, Cambridge: Cambridge University Press, 2005: "Appendix A. Begriffsschrift in Modern Notation: (1) to (51)" and "Appendix B. Begriffsschrift in Modern Notation: (52) to (68)."[a]

Die Grundlagen der Arithmetik: Eine logisch-mathematische Untersuchung über den Begriff der Zahl[145] (1884), Breslau: Verlag von Wilhelm Koebner (online version[146]).

- In English: *The Foundations of Arithmetic[147]: A Logico-Mathematical Enquiry into the Concept of Number*, translated by J. L. Austin[148], Oxford: Basil Blackwell, 1950.

Grundgesetze der Arithmetik, Band I (1893); Band II (1903), Jena: Verlag Hermann Pohle (online version)[149].

- In English (translation of selected sections), "Translation of Part of Frege's *Grundgesetze der Arithmetik*," translated and edited Peter Geach[150] and Max Black[151] in *Translations from the Philosophical Writings of Gottlob Frege*, New York, NY: Philosophical Library, 1952, pp. 137–158.
- In German (revised in modern formal notation): *Grundgesetze der Arithmetik*, Korpora (portal of the University of Duisburg-Essen[152]), 2006: Band I[153] and Band II[154].

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153 https://korpora.zim.uni-duisburg-essen.de/Frege/PDF/gga1_o_corr.pdf
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- In German (revised in modern formal notation): *Grundgesetze der Arithmetik – Begriffsschriftlich abgeleitet. Band I und II: In moderne Formelnotation transkribiert und mit einem ausführlichen Sachregister versehen*, edited by T. Müller, B. Schröder, and R. Stuhlmann-Laeisz, Paderborn: mentis, 2009.
- In English: *Basic Laws of Arithmetic*, translated and edited with an introduction by Philip A. Ebert and Marcus Rossberg. Oxford: Oxford University Press, 2013. ISBN[155] 978-0-19-928174-9[156].

1.8.2 Philosophical studies

"Function and Concept[157]" (1891)

- Original: "Funktion und Begriff", an address[158] to the Jenaische Gesellschaft für Medizin und Naturwissenschaft, Jena, 9 January 1891.
- In English: "Function and Concept".

"On Sense and Reference[159]" (1892)

- Original: "Über Sinn und Bedeutung", in *Zeitschrift für Philosophie und philosophische Kritik[160] C*(1892): 25–50.
- In English: "On Sense and Reference", alternatively translated (in later edition) as "On Sense and Meaning".

"Concept and Object[161]" (1892)

- Original: "Ueber Begriff und Gegenstand", in *Vierteljahresschrift für wissenschaftliche Philosophie XVI* (1892): 192–205.
- In English: "Concept and Object".

"What is a Function?" (1904)

- Original: "Was ist eine Funktion?", in *Festschrift Ludwig Boltzmann gewidmet zum sechzigsten Geburtstage, 20 February 1904*, S. Meyer (ed.), Leipzig, 1904, pp. 656–666. [33]
- In English: "What is a Function?".

Logical Investigations (1918–1923). Frege intended that the following three papers be published together in a book titled *Logische Untersuchungen* (*Logical Investigations*). Though the German book never appeared, the papers were published together in *Logische Untersuchungen*, ed. G. Patzig, Vandenhoeck & Ruprecht, 1966, and English translations appeared together in *Logical Investigations*, ed. Peter Geach, Blackwell, 1975.

- 1918–19. "Der Gedanke: Eine logische Untersuchung" ("The Thought: A Logical Inquiry"), in *Beiträge zur Philosophie des Deutschen Idealismus I*:[b] 58–77.

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160 https://en.wikipedia.org/wiki/Zeitschrift_f%C3%BCr_Philosophie_und_philosophische_Kritik
161 https://en.wikipedia.org/wiki/Concept_and_Object

- 1918–19. "Die Verneinung" ("Negation") in *Beiträge zur Philosophie des Deutschen Idealismus I*: 143–157.
- 1923. "Gedankengefüge" ("Compound Thought"), in *Beiträge zur Philosophie des Deutschen Idealismus III*: 36–51.

1.8.3 Articles on geometry

- 1903: "Über die Grundlagen der Geometrie". II. *Jahresbericht der deutschen Mathematiker-Vereinigung XII* (1903), 368–375.
  - In English: "On the Foundations of Geometry".
- 1967: *Kleine Schriften*. (I. Angelelli, ed.). Darmstadt: Wissenschaftliche Buchgesellschaft, 1967 and Hildesheim, G. Olms, 1967. "Small Writings," a collection of most of his writings (e.g., the previous), posthumously[162] published.

1.9 See also

- Philosophy portal[163]

- Frege system[164]
- List of pioneers in computer science[165]
- Neo-Fregeanism[166]

1.10 Notes

1. Only the proofs of Part II of the *Begriffsschrift* are rewritten in modern notation in this work. Partial rewriting of the proofs of Part III is included in Boolos, George[167], "Reading the *Begriffsschrift*," *Mind[168]* **94**(375): 331–344 (1985).
2. The journal *Beiträge zur Philosophie des Deutschen Idealismus* was the organ of Deutsche Philosophische Gesellschaft[169].

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4. Tom Rockmore[175], *On Foundationalism: A Strategy for Metaphysical Realism*, Rowman & Littlefield, 2004, p. 111.

5. Frege criticized direct realism[176] in his "Über Sinn und Bedeutung[177]" (see Samuel Lebens, *Bertrand Russell and the Nature of Propositions: A History and Defence of the Multiple Relation Theory of Judgement*, Routledge, 2017, p. 34).

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9. Gottlob Frege, *The Foundations of Arithmetic[183]*, Northwestern University Press, 1980, p. 87.

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