**Gottfried Wilhelm Leibniz**

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| [http://upload.wikimedia.org/wikipedia/commons/thumb/6/6a/Gottfried_Wilhelm_von_Leibniz.jpg/220px-Gottfried_Wilhelm_von_Leibniz.jpg](http://en.wikipedia.org/wiki/File:Gottfried_Wilhelm_von_Leibniz.jpg) Gottfried Wilhelm Leibniz | |
| **Born** | July 1, 1646 [Leipzig](http://en.wikipedia.org/wiki/Leipzig), [Electorate of Saxony](http://en.wikipedia.org/wiki/Electorate_of_Saxony) |
| **Died** | November 14, 1716(1716-11-14) (aged 70) [Hanover](http://en.wikipedia.org/wiki/Hanover), [Electorate of Hanover](http://en.wikipedia.org/wiki/Electorate_of_Hanover) |
| **Nationality** | [German](http://en.wikipedia.org/wiki/Germans) |
| **Era** | [17th-](http://en.wikipedia.org/wiki/17th-century_philosophy)/[18th-century philosophy](http://en.wikipedia.org/wiki/18th-century_philosophy) |
| **Region** | [Western Philosophy](http://en.wikipedia.org/wiki/Western_Philosophy) |
| **Main interests** | [Mathematics](http://en.wikipedia.org/wiki/Mathematics), [metaphysics](http://en.wikipedia.org/wiki/Metaphysics), [logic](http://en.wikipedia.org/wiki/Logic), [theodicy](http://en.wikipedia.org/wiki/Theodicy) |
| **Notable ideas** | [Infinitesimal calculus](http://en.wikipedia.org/wiki/Infinitesimal_calculus) [Monads](http://en.wikipedia.org/wiki/Monadology) [Best of all possible worlds](http://en.wikipedia.org/wiki/Best_of_all_possible_worlds) [Leibniz formula for π](http://en.wikipedia.org/wiki/Leibniz_formula_for_%CF%80) [Leibniz harmonic triangle](http://en.wikipedia.org/wiki/Leibniz_harmonic_triangle) [Leibniz formula for determinants](http://en.wikipedia.org/wiki/Leibniz_formula_for_determinants) [Leibniz integral rule](http://en.wikipedia.org/wiki/Leibniz_integral_rule) [Principle of sufficient reason](http://en.wikipedia.org/wiki/Principle_of_sufficient_reason) [Diagrammatic reasoning](http://en.wikipedia.org/wiki/Diagrammatic_reasoning) [Notation for differentiation](http://en.wikipedia.org/wiki/Notation_for_differentiation) [Proof of Fermat's little theorem](http://en.wikipedia.org/wiki/Fermat%27s_little_theorem) [Kinetic energy](http://en.wikipedia.org/wiki/Kinetic_energy) [Entscheidungsproblem](http://en.wikipedia.org/wiki/Entscheidungsproblem) [AST](http://en.wikipedia.org/wiki/Alternating_series_test) [Law of Continuity](http://en.wikipedia.org/wiki/Law_of_Continuity) [Transcendental Law of Homogeneity](http://en.wikipedia.org/wiki/Transcendental_Law_of_Homogeneity) [*Characteristica universalis*](http://en.wikipedia.org/wiki/Characteristica_universalis) [Calculus ratiocinator](http://en.wikipedia.org/wiki/Calculus_ratiocinator) [*Universalwissenschaft*](http://en.wikipedia.org/wiki/Universal_science)[[1]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-1), |
| Influenced by[[show]](javascript:toggleNavigationBar(1);)   * [Holy Scripture](http://en.wikipedia.org/wiki/Bible), [Plato](http://en.wikipedia.org/wiki/Plato), [Aristotle](http://en.wikipedia.org/wiki/Aristotle), [Plotinus](http://en.wikipedia.org/wiki/Plotinus), [Augustine of Hippo](http://en.wikipedia.org/wiki/Augustine_of_Hippo), [Scholasticism](http://en.wikipedia.org/wiki/Scholasticism), [Thomas Aquinas](http://en.wikipedia.org/wiki/Thomas_Aquinas), [Nicholas of Cusa](http://en.wikipedia.org/wiki/Nicholas_of_Cusa), [Suárez](http://en.wikipedia.org/wiki/Francisco_Su%C3%A1rez), [Giordano Bruno](http://en.wikipedia.org/wiki/Giordano_Bruno), [Descartes](http://en.wikipedia.org/wiki/Ren%C3%A9_Descartes), [Hobbes](http://en.wikipedia.org/wiki/Thomas_Hobbes), [Pico della Mirandola](http://en.wikipedia.org/wiki/Pico_della_Mirandola), [Jakob Thomasius](http://en.wikipedia.org/wiki/Jakob_Thomasius), [Gassendi](http://en.wikipedia.org/wiki/Pierre_Gassendi), [Malebranche](http://en.wikipedia.org/wiki/Nicolas_Malebranche), [Spinoza](http://en.wikipedia.org/wiki/Baruch_Spinoza), [Bossuet](http://en.wikipedia.org/wiki/Jacques-B%C3%A9nigne_Bossuet), [Pascal](http://en.wikipedia.org/wiki/Blaise_Pascal), [Huygens](http://en.wikipedia.org/wiki/Christiaan_Huygens), [J. Bernoulli](http://en.wikipedia.org/wiki/Jacob_Bernoulli), [Weigel](http://en.wikipedia.org/wiki/Erhard_Weigel), [Thomasius](http://en.wikipedia.org/wiki/Jakob_Thomasius), [Steno](http://en.wikipedia.org/wiki/Nicolas_Steno), [Llull](http://en.wikipedia.org/wiki/Ramon_Llull),[[2]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-Philosophy.2C_Vol_1958-2) [Confucius](http://en.wikipedia.org/wiki/Confucius) | |
| Influenced[[show]](javascript:toggleNavigationBar(2);)   * [C. Wolff](http://en.wikipedia.org/wiki/Christian_Wolff_(philosopher)), [Tetens](http://en.wikipedia.org/wiki/Johannes_Nikolaus_Tetens), [Maupertuis](http://en.wikipedia.org/wiki/Pierre_Louis_Moreau_de_Maupertuis), [Vico](http://en.wikipedia.org/wiki/Giambattista_Vico), [Boscovich](http://en.wikipedia.org/wiki/Ruggero_Giuseppe_Boscovich), [Hume](http://en.wikipedia.org/wiki/David_Hume), [Kant](http://en.wikipedia.org/wiki/Immanuel_Kant), [Bonald](http://en.wikipedia.org/wiki/Louis_de_Bonald), [Russell](http://en.wikipedia.org/wiki/Bertrand_Russell), [Varisco](http://en.wikipedia.org/wiki/Bernardino_Varisco), [Gödel](http://en.wikipedia.org/wiki/Kurt_G%C3%B6del), [Heidegger](http://en.wikipedia.org/wiki/Martin_Heidegger), [LaRouche](http://en.wikipedia.org/wiki/Lyndon_LaRouche), [Nietzsche](http://en.wikipedia.org/wiki/Friedrich_Nietzsche), [Carvalho](http://en.wikipedia.org/wiki/Olavo_de_Carvalho), [Rescher](http://en.wikipedia.org/wiki/Nicholas_Rescher), [Deleuze](http://en.wikipedia.org/wiki/Gilles_Deleuze), [Chaitin](http://en.wikipedia.org/wiki/Gregory_Chaitin), [Tarde](http://en.wikipedia.org/wiki/Gabriel_Tarde)[[3]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-3) | |
| **Signature** | [http://upload.wikimedia.org/wikipedia/commons/thumb/e/e3/Leibnitz_signature.svg/128px-Leibnitz_signature.svg.png](http://en.wikipedia.org/wiki/File:Leibnitz_signature.svg) |

**Gottfried Wilhelm Leibniz** (sometimes **von Leibniz** or **Leibnitz**) (German: [[ˈɡɔtfʁiːt ˈvɪlhɛlm fɔn ˈlaɪbnɪts]](http://en.wikipedia.org/wiki/Help:IPA_for_German)[[4]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-4) or [[ˈlaɪpnɪts]](http://en.wikipedia.org/wiki/Help:IPA_for_German)[[5]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-5)) (July 1, 1646 – November 14, 1716) was a [German](http://en.wikipedia.org/wiki/Germans) [mathematician](http://en.wikipedia.org/wiki/Mathematician) and [philosopher](http://en.wikipedia.org/wiki/Philosopher).

Leibniz occupies a prominent place in the [history of mathematics](http://en.wikipedia.org/wiki/History_of_mathematics) and the [history of philosophy](http://en.wikipedia.org/wiki/History_of_philosophy). He developed the [infinitesimal calculus](http://en.wikipedia.org/wiki/Infinitesimal_calculus) independently of [Isaac Newton](http://en.wikipedia.org/wiki/Sir_Isaac_Newton), and [Leibniz's mathematical notation](http://en.wikipedia.org/wiki/Leibniz%27s_notation) has been widely used ever since it was published. His visionary [Law of Continuity](http://en.wikipedia.org/wiki/Law_of_Continuity) and [Transcendental Law of Homogeneity](http://en.wikipedia.org/wiki/Transcendental_Law_of_Homogeneity) only found mathematical implementation in the 20th century. He became one of the most prolific inventors in the field of [mechanical calculators](http://en.wikipedia.org/wiki/Mechanical_calculator). While working on adding automatic multiplication and division to [Pascal's calculator](http://en.wikipedia.org/wiki/Pascal%27s_calculator), he was the first to describe a [pinwheel calculator](http://en.wikipedia.org/wiki/Pinwheel_calculator) in 1685[[6]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-6) and invented the [Leibniz wheel](http://en.wikipedia.org/wiki/Leibniz_wheel), used in the [arithmometer](http://en.wikipedia.org/wiki/Arithmometer), the first mass-produced mechanical calculator. He also refined the [binary number system](http://en.wikipedia.org/wiki/Binary_number_system), which is at the foundation of virtually all [digital computers](http://en.wikipedia.org/wiki/Digital_computer). In philosophy, Leibniz is mostly noted for his optimism, *e.g.*, his conclusion that our [Universe](http://en.wikipedia.org/wiki/Universe) is, in a restricted sense, the best possible one that [God](http://en.wikipedia.org/wiki/God) could have created. Leibniz, along with [René Descartes](http://en.wikipedia.org/wiki/Ren%C3%A9_Descartes) and [Baruch Spinoza](http://en.wikipedia.org/wiki/Baruch_Spinoza), was one of the three great 17th century advocates of [rationalism](http://en.wikipedia.org/wiki/Rationalism). The work of Leibniz anticipated modern [logic](http://en.wikipedia.org/wiki/Logic) and [analytic philosophy](http://en.wikipedia.org/wiki/Analytic_philosophy), but his philosophy also looks back to the [scholastic](http://en.wikipedia.org/wiki/Scholasticism) tradition, in which conclusions are produced by applying reason to first principles or prior definitions rather than to empirical evidence. Leibniz made major contributions to [physics](http://en.wikipedia.org/wiki/Physics) and [technology](http://en.wikipedia.org/wiki/Technology), and anticipated notions that surfaced much later in [philosophy](http://en.wikipedia.org/wiki/Philosophy), [probability theory](http://en.wikipedia.org/wiki/Probability_theory), [biology](http://en.wikipedia.org/wiki/Biology), [medicine](http://en.wikipedia.org/wiki/Medicine), [geology](http://en.wikipedia.org/wiki/Geology), [psychology](http://en.wikipedia.org/wiki/Psychology), [linguistics](http://en.wikipedia.org/wiki/Linguistics), and [information science](http://en.wikipedia.org/wiki/Information_science). He wrote works on [philosophy](http://en.wikipedia.org/wiki/Philosophy), [politics](http://en.wikipedia.org/wiki/Politics), [law](http://en.wikipedia.org/wiki/Law), [ethics](http://en.wikipedia.org/wiki/Ethics), [theology](http://en.wikipedia.org/wiki/Theology), [history](http://en.wikipedia.org/wiki/History), and [philology](http://en.wikipedia.org/wiki/Philology). Leibniz's contributions to this vast array of subjects were scattered in various [learned journals](http://en.wikipedia.org/wiki/Learned_journal), in tens of thousands of letters, and in unpublished manuscripts. He wrote in several languages, but primarily in [Latin](http://en.wikipedia.org/wiki/Latin), [French](http://en.wikipedia.org/wiki/French_language), and [German](http://en.wikipedia.org/wiki/German_language).[[7]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-7) As of 2012, there is no complete gathering of the writings of Leibniz.[[8]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-8)

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**Biography**

**Early life**

Gottfried Leibniz was born on July 1, 1646 in [Leipzig](http://en.wikipedia.org/wiki/Leipzig), [Saxony](http://en.wikipedia.org/wiki/Saxony) (at the end of the [Thirty Years' War](http://en.wikipedia.org/wiki/Thirty_Years%27_War)), to [Friedrich Leibniz](http://en.wikipedia.org/wiki/Friedrich_Leibniz) and Catharina Schmuck. Friedrich noted in his family journal: "On Sunday 21 June [NS: 1 July] 1646, my son Gottfried Wilhelm is born into the world after six in the evening, ¾ to seven [ein Viertel uff sieben], Aquarius rising."[[9]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-9) His father (a German of [Sorbian](http://en.wikipedia.org/wiki/Sorbs) ancestry[[10]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-10)) died when Leibniz was six years old, and from that point on he was raised by his mother. Her teachings influenced Leibniz's philosophical thoughts in his later life.

Leibniz's father had been a Professor of Moral Philosophy at the [University of Leipzig](http://en.wikipedia.org/wiki/University_of_Leipzig) and Leibniz inherited his father's personal library. He was given free access to this from the age of seven. While Leibniz's schoolwork focused on a small canon of authorities, his father's library enabled him to study a wide variety of advanced philosophical and theological works – ones that he would not have otherwise been able to read until his college years.[[11]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-11) Access to his father's library, largely written in Latin, also led to his proficiency in the Latin language. Leibniz was proficient in Latin by the age of 12, and he composed three hundred hexameters of Latin verse in a single morning for a special event at school at the age of 13.[[12]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-12)

He enrolled in his father's former university at age 15,[[13]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-13) and he completed his [bachelor's degree](http://en.wikipedia.org/wiki/Bachelor%27s_degree) in philosophy in December 1662. He defended his *Disputatio Metaphysica de Principio Individui*, which addressed the [principle of individuation](http://en.wikipedia.org/wiki/Principle_of_individuation), on June 9, 1663. Leibniz earned his [master's degree](http://en.wikipedia.org/wiki/Master%27s_degree) in philosophy on February 7, 1664. He published and defended a dissertation *Specimen Quaestionum Philosophicarum ex Jure collectarum*, arguing for both a theoretical and a pedagogical relationship between philosophy and law, in December 1664. After one year of legal studies, he was awarded his bachelor's degree in Law on September 28, 1665.[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]

In 1666, at age 20, Leibniz published his first book, [*On the Art of Combinations*](http://en.wikipedia.org/wiki/De_Arte_Combinatoria), the first part of which was also his [habilitation](http://en.wikipedia.org/wiki/Habilitation) thesis in philosophy. His next goal was to earn his license and doctorate in Law, which normally required three years of study then. In 1666, the University of Leipzig turned down Leibniz's doctoral application and refused to grant him a doctorate in law, most likely due to his relative youth (he was 21 years old at the time).[[14]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-14) Leibniz subsequently left Leipzig.[[15]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-15)

Leibniz then enrolled in the [University of Altdorf](http://en.wikipedia.org/wiki/University_of_Altdorf), and almost immediately he submitted a thesis, which he had probably been working on earlier in Leipzig.[[16]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-16) The title of his thesis was *Disputatio Inauguralis De Casibus Perplexis In Jure*. Leibniz earned his license to practice law and his Doctorate in Law in November 1666. He next declined the offer of an academic appointment at Altdorf, saying that "my thoughts were turned in an entirely different direction.[[17]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-17)

As an adult, Leibniz often introduced himself as "Gottfried von Leibniz". Also many posthumously published editions of his writings presented his name on the title page as "[Freiherr](http://en.wikipedia.org/wiki/Freiherr) G. W. von Leibniz." However, no document has ever been found from any contemporary government that stated his appointment to any form of [nobility](http://en.wikipedia.org/wiki/Nobility).[[18]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-18)

**1666–74**

Leibniz's first position was as a salaried [alchemist](http://en.wikipedia.org/wiki/Alchemy) in [Nuremberg](http://en.wikipedia.org/wiki/Nuremberg), though he may have only known fairly little about the subject at that time.[[19]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-19) He soon met [Johann Christian von Boyneburg](http://en.wikipedia.org/wiki/Johann_Christian_von_Boyneburg) (1622–1672), the dismissed chief minister of the Elector of [Mainz](http://en.wikipedia.org/wiki/Mainz), [Johann Philipp von Schönborn](http://en.wikipedia.org/wiki/Johann_Philipp_von_Sch%C3%B6nborn).[[20]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-20) Von Boyneburg hired Leibniz as an assistant, and shortly thereafter reconciled with the Elector and introduced Leibniz to him. Leibniz then dedicated an essay on law to the Elector in the hope of obtaining employment. The stratagem worked; the Elector asked Leibniz to assist with the redrafting of the legal code for his Electorate.[[21]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-21) In 1669, Leibniz was appointed Assessor in the Court of Appeal. Although von Boyneburg died late in 1672, Leibniz remained under the employment of his widow until she dismissed him in 1674.

Von Boyneburg did much to promote Leibniz's reputation, and the latter's memoranda and letters began to attract favorable notice. Leibniz's service to the Elector soon followed a [diplomatic](http://en.wikipedia.org/wiki/Diplomat) role. He published an essay, under the pseudonym of a fictitious [Polish](http://en.wikipedia.org/wiki/Poland) nobleman, arguing (unsuccessfully) for the German candidate for the Polish crown. The main force in [European](http://en.wikipedia.org/wiki/Europe) geopolitics during Leibniz's adult life was the ambition of [Louis XIV of France](http://en.wikipedia.org/wiki/Louis_XIV_of_France), backed by French military and economic might. Meanwhile, the [Thirty Years' War](http://en.wikipedia.org/wiki/Thirty_Years%27_War) had left [German-speaking Europe](http://en.wikipedia.org/wiki/German_language_in_Europe) exhausted, fragmented, and economically backward. Leibniz proposed to protect German-speaking Europe by distracting Louis as follows. France would be invited to take [Egypt](http://en.wikipedia.org/wiki/Egypt) as a stepping stone towards an eventual conquest of the [Dutch East Indies](http://en.wikipedia.org/wiki/Dutch_East_Indies). In return, France would agree to leave Germany and the Netherlands undisturbed. This plan obtained the Elector's cautious support. In 1672, the French government invited Leibniz to [Paris](http://en.wikipedia.org/wiki/Paris) for discussion,[[22]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-22) but the plan was soon overtaken by the outbreak of the [Franco-Dutch War](http://en.wikipedia.org/wiki/Franco-Dutch_War) and became irrelevant. Napoleon's failed invasion of Egypt in 1798 can be seen as an unwitting implementation of Leibniz's plan.

Thus Leibniz began several years in Paris. Soon after arriving, he met [Dutch](http://en.wikipedia.org/wiki/Netherlands) physicist and mathematician [Christiaan Huygens](http://en.wikipedia.org/wiki/Christiaan_Huygens) and realised that his own knowledge of mathematics and physics was patchy. With Huygens as mentor, he began a program of [self-study](http://en.wikipedia.org/wiki/Self-study) that soon pushed him to making major contributions to both subjects, including inventing his version of the differential and integral [calculus](http://en.wikipedia.org/wiki/Infinitesimal_calculus). He met [Nicolas Malebranche](http://en.wikipedia.org/wiki/Nicolas_Malebranche) and [Antoine Arnauld](http://en.wikipedia.org/wiki/Antoine_Arnauld), the leading French philosophers of the day, and studied the writings of [Descartes](http://en.wikipedia.org/wiki/Descartes) and [Pascal](http://en.wikipedia.org/wiki/Blaise_Pascal), unpublished as well as published. He befriended a German mathematician, [Ehrenfried Walther von Tschirnhaus](http://en.wikipedia.org/wiki/Ehrenfried_Walther_von_Tschirnhaus); they corresponded for the rest of their lives. In 1675 he was admitted by the [French Academy of Sciences](http://en.wikipedia.org/wiki/French_Academy_of_Sciences) as a foreign honorary member, despite his lack of attention to the academy.

[](http://en.wikipedia.org/wiki/File:Leibnitzrechenmaschine.jpg)

[Stepped Reckoner](http://en.wikipedia.org/wiki/Stepped_Reckoner)

When it became clear that France would not implement its part of Leibniz's Egyptian plan, the Elector sent his nephew, escorted by Leibniz, on a related mission to the English government in [London](http://en.wikipedia.org/wiki/London), early in 1673.[[23]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-23) There Leibniz came into acquaintance of [Henry Oldenburg](http://en.wikipedia.org/wiki/Henry_Oldenburg) and [John Collins](http://en.wikipedia.org/wiki/John_Collins_(mathematician)). He met with the [Royal Society](http://en.wikipedia.org/wiki/Royal_Society) where he demonstrated a calculating machine that he had designed and had been building since 1670. The machine was able to execute all four basic operations (adding, subtracting, multiplying, and dividing), and the Society quickly made him an external member. The mission ended abruptly when news reached it of the Elector's death, whereupon Leibniz promptly returned to Paris and not, as had been planned, to Mainz.[[24]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-24)

The sudden deaths of Leibniz's two patrons in the same winter meant that Leibniz had to find a new basis for his career. In this regard, a 1669 invitation from the Duke of [Brunswick](http://en.wikipedia.org/wiki/Brunswick-L%C3%BCneburg) to visit Hanover proved fateful. Leibniz declined the invitation, but began corresponding with the Duke in 1671. In 1673, [the Duke](http://en.wikipedia.org/wiki/John_Frederick,_Duke_of_Brunswick-L%C3%BCneburg) offered him the post of Counsellor which Leibniz very reluctantly accepted two years later, only after it became clear that no employment in Paris, whose intellectual stimulation he relished, or with the [Habsburg](http://en.wikipedia.org/wiki/Habsburg) imperial court was forthcoming.

**House of Hanover, 1676–1716**

Leibniz managed to delay his arrival in Hanover until the end of 1676 after making one more short journey to London, where he was later accused by Newton of being shown some of Newton's unpublished work on the calculus.[[25]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-25) This fact was deemed evidence supporting the accusation, made decades later, that he had stolen the calculus from Newton. On the journey from London to Hanover, Leibniz stopped in [The Hague](http://en.wikipedia.org/wiki/The_Hague) where he met [Leeuwenhoek](http://en.wikipedia.org/wiki/Leeuwenhoek), the discoverer of microorganisms. He also spent several days in intense discussion with [Spinoza](http://en.wikipedia.org/wiki/Spinoza), who had just completed his masterwork, the [*Ethics*](http://en.wikipedia.org/wiki/Ethics_(book)).[[26]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-26) Leibniz respected Spinoza's powerful intellect, but was dismayed by his conclusions that contradicted both Christian and Jewish orthodoxy.

In 1677, he was promoted, at his request, to Privy Counselor of Justice, a post he held for the rest of his life. Leibniz served three consecutive rulers of the House of Brunswick as historian, political adviser, and most consequentially, as librarian of the [ducal](http://en.wikipedia.org/wiki/Duke) library. He thenceforth employed his pen on all the various political, historical, and [theological](http://en.wikipedia.org/wiki/Theological) matters involving the House of Brunswick; the resulting documents form a valuable part of the historical record for the period.

Among the few people in north Germany to accept Leibniz were the Electress [Sophia of Hanover](http://en.wikipedia.org/wiki/Sophia_of_Hanover) (1630–1714), her daughter [Sophia Charlotte of Hanover](http://en.wikipedia.org/wiki/Sophia_Charlotte_of_Hanover) (1668–1705), the Queen of Prussia and his avowed disciple, and [Caroline of Ansbach](http://en.wikipedia.org/wiki/Caroline_of_Ansbach), the consort of her grandson, the future [George II](http://en.wikipedia.org/wiki/George_II_of_Great_Britain). To each of these women he was correspondent, adviser, and friend. In turn, they all approved of Leibniz more than did their spouses and the future king [George I of Great Britain](http://en.wikipedia.org/wiki/George_I_of_Great_Britain).[[27]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-27)

The population of Hanover was only about 10,000, and its provinciality eventually grated on Leibniz. Nevertheless, to be a major courtier to the House of [Brunswick](http://en.wikipedia.org/wiki/Brunswick-L%C3%BCneburg) was quite an honor, especially in light of the meteoric rise in the prestige of that House during Leibniz's association with it. In 1692, the Duke of Brunswick became a hereditary Elector of the [Holy Roman Empire](http://en.wikipedia.org/wiki/Holy_Roman_Empire). The British [Act of Settlement 1701](http://en.wikipedia.org/wiki/Act_of_Settlement_1701) designated the Electress Sophia and her descent as the royal family of England, once both King [William III](http://en.wikipedia.org/wiki/William_III_of_England) and his sister-in-law and successor, [Queen Anne](http://en.wikipedia.org/wiki/Anne_of_Great_Britain), were dead. Leibniz played a role in the initiatives and negotiations leading up to that Act, but not always an effective one. For example, something he published anonymously in England, thinking to promote the Brunswick cause, was formally censured by the [British Parliament](http://en.wikipedia.org/wiki/British_Parliament).

The Brunswicks tolerated the enormous effort Leibniz devoted to intellectual pursuits unrelated to his duties as a courtier, pursuits such as perfecting the calculus, writing about other mathematics, logic, physics, and philosophy, and keeping up a vast correspondence. He began working on the calculus in 1674; the earliest evidence of its use in his surviving notebooks is 1675. By 1677 he had a coherent system in hand, but did not publish it until 1684. Leibniz's most important mathematical papers were published between 1682 and 1692, usually in a journal which he and Otto Mencke founded in 1682, the [*Acta Eruditorum*](http://en.wikipedia.org/wiki/Acta_Eruditorum). That journal played a key role in advancing his mathematical and scientific reputation, which in turn enhanced his eminence in diplomacy, history, theology, and philosophy.

The Elector [Ernest Augustus](http://en.wikipedia.org/wiki/Ernest_Augustus,_Elector_of_Brunswick-L%C3%BCneburg) commissioned Leibniz to write a history of the House of Brunswick, going back to the time of [Charlemagne](http://en.wikipedia.org/wiki/Charlemagne) or earlier, hoping that the resulting book would advance his dynastic ambitions. From 1687 to 1690, Leibniz traveled extensively in Germany, Austria, and Italy, seeking and finding archival materials bearing on this project. Decades went by but no history appeared; the next Elector became quite annoyed at Leibniz's apparent dilatoriness. Leibniz never finished the project, in part because of his huge output on many other fronts, but also because he insisted on writing a meticulously researched and erudite book based on archival sources, when his patrons would have been quite happy with a short popular book, one perhaps little more than a [genealogy](http://en.wikipedia.org/wiki/Genealogy) with commentary, to be completed in three years or less. They never knew that he had in fact carried out a fair part of his assigned task: when the material Leibniz had written and collected for his history of the House of Brunswick was finally published in the 19th century, it filled three volumes.

In 1708, [John Keill](http://en.wikipedia.org/wiki/John_Keill), writing in the journal of the Royal Society and with Newton's presumed blessing, accused Leibniz of having plagiarized Newton's calculus.[[28]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-28) Thus began the [calculus priority dispute](http://en.wikipedia.org/wiki/Newton_v._Leibniz_calculus_controversy) which darkened the remainder of Leibniz's life. A formal investigation by the Royal Society (in which Newton was an unacknowledged participant), undertaken in response to Leibniz's demand for a retraction, upheld Keill's charge. Historians of mathematics writing since 1900 or so have tended to acquit Leibniz, pointing to important differences between Leibniz's and Newton's versions of the calculus.

[](http://en.wikipedia.org/wiki/File:Korespondencja_Gottfrieda_Leibniza.jpg)

Leibniz's correspondence, papers and notes from 1669-1704, [National Library of Poland](http://en.wikipedia.org/wiki/National_Library_of_Poland).

In 1711, while traveling in northern Europe, the Russian [Tsar](http://en.wikipedia.org/wiki/Tsar) [Peter the Great](http://en.wikipedia.org/wiki/Peter_I_of_Russia) stopped in Hanover and met Leibniz, who then took some interest in Russian matters for the rest of his life. In 1712, Leibniz began a two-year residence in [Vienna](http://en.wikipedia.org/wiki/Vienna), where he was appointed Imperial Court Councillor to the [Habsburgs](http://en.wikipedia.org/wiki/Habsburg). On the death of Queen Anne in 1714, Elector George Louis became King [George I of Great Britain](http://en.wikipedia.org/wiki/George_I_of_Great_Britain), under the terms of the 1701 Act of Settlement. Even though Leibniz had done much to bring about this happy event, it was not to be his hour of glory. Despite the intercession of the Princess of Wales, Caroline of Ansbach, George I forbade Leibniz to join him in London until he completed at least one volume of the history of the Brunswick family his father had commissioned nearly 30 years earlier. Moreover, for George I to include Leibniz in his London court would have been deemed insulting to Newton, who was seen as having won the calculus priority dispute and whose standing in British official circles could not have been higher. Finally, his dear friend and defender, the Dowager Electress Sophia, died in 1714.

**Death**

Leibniz died in [Hanover](http://en.wikipedia.org/wiki/Hanover) in 1716: at the time, he was so out of favor that neither George I (who happened to be near Hanover at the time) nor any fellow courtier other than his personal secretary attended the funeral. Even though Leibniz was a life member of the Royal Society and the [Berlin Academy of Sciences](http://en.wikipedia.org/wiki/Prussian_Academy_of_Sciences), neither organization saw fit to honor his passing. His grave went unmarked for more than 50 years. Leibniz was eulogized by [Fontenelle](http://en.wikipedia.org/wiki/Bernard_de_Fontenelle), before the [Academie des Sciences](http://en.wikipedia.org/wiki/Academie_des_Sciences) in Paris, which had admitted him as a foreign member in 1700. The eulogy was composed at the behest of the [Duchess of Orleans](http://en.wikipedia.org/wiki/Elizabeth_Charlotte,_Princess_Palatine), a niece of the Electress Sophia.

**Personal life**

Leibniz never married. He complained on occasion about money, but the fair sum he left to his sole heir, his sister's stepson, proved that the Brunswicks had, by and large, paid him well. In his diplomatic endeavors, he at times verged on the unscrupulous, as was all too often the case with professional diplomats of his day. On several occasions, Leibniz backdated and altered personal manuscripts, actions which put him in a bad light during the calculus controversy. On the other hand, he was charming, well-mannered, and not without humor and imagination.[[29]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-29) He had many friends and admirers all over Europe. On Leibniz's religious views, although he is considered by some biographers as a [deist](http://en.wikipedia.org/wiki/Deist) since he did not believe in miracles and that [Jesus Christ](http://en.wikipedia.org/wiki/Jesus_Christ) has no real role in the universe, he was nonetheless a [theist](http://en.wikipedia.org/wiki/Theist).[[30]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-30)[[31]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-31)[[32]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-32)[[33]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-33)

**Philosopher**

Leibniz's philosophical thinking appears fragmented, because his philosophical writings consist mainly of a multitude of short pieces: journal articles, manuscripts published long after his death, and many letters to many correspondents. He wrote only two book-length philosophical treatises, of which only the *Théodicée* of 1710 was published in his lifetime.

Leibniz dated his beginning as a philosopher to his [*Discourse on Metaphysics*](http://en.wikipedia.org/wiki/Discourse_on_Metaphysics), which he composed in 1686 as a commentary on a running dispute between [Nicolas Malebranche](http://en.wikipedia.org/wiki/Nicolas_Malebranche) and [Antoine Arnauld](http://en.wikipedia.org/wiki/Antoine_Arnauld). This led to an extensive and valuable correspondence with Arnauld;[[34]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-34) it and the *Discourse* were not published until the 19th century. In 1695, Leibniz made his public entrée into European philosophy with a journal article titled "New System of the Nature and Communication of Substances".[[35]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-35) Between 1695 and 1705, he composed his [*New Essays on Human Understanding*](http://en.wikipedia.org/wiki/New_Essays_on_Human_Understanding), a lengthy commentary on [John Locke](http://en.wikipedia.org/wiki/John_Locke)'s 1690 [*An Essay Concerning Human Understanding*](http://en.wikipedia.org/wiki/An_Essay_Concerning_Human_Understanding), but upon learning of Locke's 1704 death, lost the desire to publish it, so that the *New Essays* were not published until 1765. The [*Monadologie*](http://en.wikipedia.org/wiki/Monadology), composed in 1714 and published posthumously, consists of 90 aphorisms.

Leibniz met [Spinoza](http://en.wikipedia.org/wiki/Spinoza) in 1676, read some of his unpublished writings, and has since been suspected of appropriating some of Spinoza's ideas. While Leibniz admired Spinoza's powerful intellect, he was also forthrightly dismayed by Spinoza's conclusions,[[36]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-36) especially when these were inconsistent with Christian orthodoxy.

Unlike Descartes and Spinoza, Leibniz had a thorough university education in philosophy. He was influenced by his [Leipzig](http://en.wikipedia.org/wiki/Leipzig) professor [Jakob Thomasius](http://en.wikipedia.org/wiki/Jakob_Thomasius), who also supervised his BA thesis in philosophy. Leibniz also eagerly read [Francisco Suárez](http://en.wikipedia.org/wiki/Francisco_Su%C3%A1rez), a Spanish [Jesuit](http://en.wikipedia.org/wiki/Society_of_Jesus) respected even in [Lutheran](http://en.wikipedia.org/wiki/Lutheranism) universities. Leibniz was deeply interested in the new methods and conclusions of Descartes, Huygens, Newton, and [Boyle](http://en.wikipedia.org/wiki/Robert_Boyle), but viewed their work through a lens heavily tinted by scholastic notions. Yet it remains the case that Leibniz's methods and concerns often anticipate the [logic](http://en.wikipedia.org/wiki/Logic), and [analytic](http://en.wikipedia.org/wiki/Analytic_philosophy) and [linguistic philosophy](http://en.wikipedia.org/wiki/Linguistic_philosophy) of the 20th century.

**The Principles**

Leibniz variously invoked one or another of seven fundamental philosophical Principles:[[37]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-37)

* [Identity](http://en.wikipedia.org/wiki/Identity_(mathematics))/[contradiction](http://en.wikipedia.org/wiki/Contradiction). If a proposition is true, then its negation is false and vice versa.
* [Identity of indiscernibles](http://en.wikipedia.org/wiki/Identity_of_indiscernibles). Two distinct things cannot have all their properties in common. If every predicate possessed by x is also possessed by y and vice versa, then entities x and y are identical; to suppose two things indiscernible is to suppose the same thing under two names. Frequently invoked in modern logic and philosophy. The "identity of indiscernibles" is often referred to as Leibniz's Law. It has attracted the most controversy and criticism, especially from corpuscular philosophy and quantum mechanics.
* [Sufficient reason](http://en.wikipedia.org/wiki/Principle_of_sufficient_reason). "There must be a sufficient reason [often known only to God] for anything to exist, for any event to occur, for any truth to obtain."[[38]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-38)
* [Pre-established harmony](http://en.wikipedia.org/wiki/Pre-established_harmony).[[39]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-39) "[T]he appropriate nature of each substance brings it about that what happens to one corresponds to what happens to all the others, without, however, their acting upon one another directly." (*Discourse on Metaphysics*, XIV) A dropped glass shatters because it "knows" it has hit the ground, and not because the impact with the ground "compels" the glass to split.
* [Law of Continuity](http://en.wikipedia.org/wiki/Law_of_Continuity). *Natura non saltum facit*.
* [Optimism](http://en.wikipedia.org/wiki/Optimism). "God assuredly always chooses the best."[[40]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-40)
* [Plenitude](http://en.wikipedia.org/wiki/Plenitude_principle). "Leibniz believed that the best of all possible worlds would actualize every genuine possibility, and argued in [Théodicée](http://en.wikipedia.org/wiki/Th%C3%A9odic%C3%A9e) that this best of all possible worlds will contain all possibilities, with our finite experience of eternity giving no reason to dispute nature's perfection."

Leibniz would on occasion give a rational defense of a specific principle, but more often took them for granted.[[41]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-41)

**The monads**

Leibniz's best known contribution to [metaphysics](http://en.wikipedia.org/wiki/Metaphysics) is his theory of [monads](http://en.wikipedia.org/wiki/Monad_(Greek_philosophy)), as exposited in [*Monadologie*](http://en.wikipedia.org/wiki/Monadology). According to Leibniz, monads are [elementary particles](http://en.wikipedia.org/wiki/Elementary_particles) with blurred perception of each other. Monads can also be compared to the corpuscles of the Mechanical Philosophy of René Descartes and others. Monads are the ultimate elements of the [universe](http://en.wikipedia.org/wiki/Universe). The monads are "substantial forms of being" with the following properties: they are eternal, indecomposable, individual, subject to their own laws, un-interacting, and each reflecting the entire universe in a [pre-established harmony](http://en.wikipedia.org/wiki/Pre-established_harmony) (a historically important example of [panpsychism](http://en.wikipedia.org/wiki/Panpsychism)). Monads are centers of [force](http://en.wikipedia.org/wiki/Force); substance is force, while [space](http://en.wikipedia.org/wiki/Space), [matter](http://en.wikipedia.org/wiki/Matter), and [motion](http://en.wikipedia.org/wiki/Motion_(physics)) are merely phenomenal.

The [ontological](http://en.wikipedia.org/wiki/Ontology) essence of a monad is its irreducible simplicity. Unlike atoms, monads possess no material or spatial character. They also differ from atoms by their complete mutual independence, so that interactions among monads are only apparent. Instead, by virtue of the principle of pre-established harmony, each monad follows a preprogrammed set of "instructions" peculiar to itself, so that a monad "knows" what to do at each moment. (These "instructions" may be seen as analogs of the [scientific laws](http://en.wikipedia.org/wiki/Scientific_law) governing [subatomic particles](http://en.wikipedia.org/wiki/Subatomic_particle).) By virtue of these intrinsic instructions, each monad is like a little mirror of the universe. Monads need not be "small"; e.g., each human being constitutes a monad, in which case [free will](http://en.wikipedia.org/wiki/Free_will) is problematic. [God](http://en.wikipedia.org/wiki/God), too, is a monad, and the [existence of God](http://en.wikipedia.org/wiki/Existence_of_God) can be inferred from the harmony prevailing among all other monads; God wills the pre-established harmony.

Monads are purported to have gotten rid of the problematic:

* Interaction between [mind](http://en.wikipedia.org/wiki/Mind) and matter arising in the system of [Descartes](http://en.wikipedia.org/wiki/Descartes);
* Lack of [individuation](http://en.wikipedia.org/wiki/Principle_of_individuation) inherent to the system of [Spinoza](http://en.wikipedia.org/wiki/Spinoza), which represents individual creatures as merely accidental.

**Theodicy and optimism**

(Note that the word "optimism" here is used in the classic sense of optimal, not in the mood-related sense, as being positively hopeful.)

The [*Theodicy*](http://en.wikipedia.org/wiki/Th%C3%A9odic%C3%A9e)[[42]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-42) tries to justify the apparent imperfections of the world by claiming that it is [optimal among all possible worlds](http://en.wikipedia.org/wiki/Best_of_all_possible_worlds). It must be the best possible and most balanced world, because it was created by an all powerful and all knowing God, who would not choose to create an imperfect world if a better world could be known to him or possible to exist. In effect, apparent flaws that can be identified in this world must exist in every possible world, because otherwise God would have chosen to create the world that excluded those flaws.

Leibniz asserted that the truths of theology (religion) and philosophy cannot contradict each other, since reason and faith are both "gifts of God" so that their conflict would imply God contending against himself. The *Theodicy* is Leibniz's attempt to reconcile his personal philosophical system with his interpretation of the tenets of Christianity.[[43]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-43) This project was motivated in part by Leibniz's belief, shared by many conservative philosophers and theologians during the [Enlightenment](http://en.wikipedia.org/wiki/Age_of_Enlightenment), in the rational and enlightened nature of the Christian religion, at least as this was defined in tendentious comparisons between Christian and non Western or "primitive" religious practices and beliefs. It was also shaped by Leibniz's belief in the perfectibility of human nature (if humanity relied on correct philosophy and religion as a guide), and by his belief that metaphysical necessity must have a rational or logical foundation, even if this metaphysical causality seemed inexplicable in terms of physical necessity (the natural laws identified by science).

Because reason and faith must be entirely reconciled, any tenet of faith which could not be defended by reason must be rejected. Leibniz then approached one of the central criticisms of Christian theism:[[44]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-44) if God is all good, all wise and all powerful, how did evil come into the world? The answer (according to Leibniz) is that, while God is indeed unlimited in wisdom and power, his human creations, as creations, are limited both in their wisdom and in their will (power to act). This predisposes humans to false beliefs, wrong decisions and ineffective actions in the exercise of their free will. God does not arbitrarily inflict pain and suffering on humans; rather he permits both *moral evil* (sin) and *physical evil* (pain and suffering) as the necessary consequences of *metaphysical evil* (imperfection), as a means by which humans can identify and correct their erroneous decisions, and as a contrast to true good.

Further, although human actions flow from prior causes that ultimately arise in God, and therefore are known as a metaphysical certainty to God, an individual's free will is exercised within natural laws, where choices are merely contingently necessary, to be decided in the event by a "wonderful spontaneity" that provides individuals an escape from rigorous predestination.

This theory drew controversy and refutations, that are collected in the article [Best of all possible worlds](http://en.wikipedia.org/wiki/Best_of_all_possible_worlds).

**Symbolic thought**

Leibniz believed that much of human reasoning could be reduced to calculations of a sort, and that such calculations could resolve many differences of opinion:

The only way to rectify our reasonings is to make them as tangible as those of the Mathematicians, so that we can find our error at a glance, and when there are disputes among persons, we can simply say: Let us calculate [*calculemus*], without further ado, to see who is right.[[45]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-45)

Leibniz's [calculus ratiocinator](http://en.wikipedia.org/wiki/Calculus_ratiocinator), which resembles [symbolic logic](http://en.wikipedia.org/wiki/Mathematical_logic), can be viewed as a way of making such calculations feasible. Leibniz wrote memoranda[[46]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-46) that can now be read as groping attempts to get symbolic logic—and thus his *calculus*—off the ground. But Gerhard and Couturat did not publish these writings until modern formal logic had emerged in [Frege's](http://en.wikipedia.org/wiki/Gottlob_Frege) [*Begriffsschrift*](http://en.wikipedia.org/wiki/Begriffsschrift) and in writings by [Charles Sanders Peirce](http://en.wikipedia.org/wiki/Charles_Sanders_Peirce) and his students in the 1880s, and hence well after [Boole](http://en.wikipedia.org/wiki/George_Boole) and [De Morgan](http://en.wikipedia.org/wiki/Augustus_De_Morgan) began that logic in 1847.

Leibniz thought [symbols](http://en.wikipedia.org/wiki/Symbol) were important for human understanding. He attached so much importance to the invention of good notations that he attributed all his discoveries in mathematics to this. His notation for the [infinitesimal calculus](http://en.wikipedia.org/wiki/Infinitesimal_calculus) is an example of his skill in this regard. C.S. Peirce, a 19th-century pioneer of [semiotics](http://en.wikipedia.org/wiki/Semiotics), shared Leibniz's passion for symbols and notation, and his belief that these are essential to a well-running logic and mathematics.

But Leibniz took his speculations much further. Defining a [character](http://en.wikipedia.org/wiki/Grapheme) as any written sign, he then defined a "real" character as one that represents an idea directly and not simply as the word embodying the idea. Some real characters, such as the notation of logic, serve only to facilitate reasoning. Many characters well known in his day, including [Egyptian hieroglyphics](http://en.wikipedia.org/wiki/Egyptian_hieroglyphics), [Chinese characters](http://en.wikipedia.org/wiki/Chinese_character), and the symbols of [astronomy](http://en.wikipedia.org/wiki/Astronomy) and [chemistry](http://en.wikipedia.org/wiki/Chemistry), he deemed not real.[[47]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-47) Instead, he proposed the creation of a [*characteristica universalis*](http://en.wikipedia.org/wiki/Characteristica_universalis) or "universal characteristic", built on an [alphabet of human thought](http://en.wikipedia.org/wiki/Alphabet_of_human_thought) in which each fundamental concept would be represented by a unique "real" character:

It is obvious that if we could find characters or signs suited for expressing all our thoughts as clearly and as exactly as arithmetic expresses numbers or geometry expresses lines, we could do in all matters *insofar as they are subject to reasoning* all that we can do in arithmetic and geometry. For all investigations which depend on reasoning would be carried out by transposing these characters and by a species of calculus.[[48]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-48)

Complex thoughts would be represented by combining characters for simpler thoughts. Leibniz saw that the uniqueness of [prime factorization](http://en.wikipedia.org/wiki/Prime_factorization) suggests a central role for [prime numbers](http://en.wikipedia.org/wiki/Prime_numbers) in the universal characteristic, a striking anticipation of [Gödel numbering](http://en.wikipedia.org/wiki/G%C3%B6del_numbering). Granted, there is no intuitive or [mnemonic](http://en.wikipedia.org/wiki/Mnemonic) way to number any set of elementary concepts using the prime numbers. Leibniz's idea of reasoning through a universal language of symbols and calculations however remarkably foreshadows great 20th century developments in formal systems, such as [Turing completeness](http://en.wikipedia.org/wiki/Turing_completeness), where computation was used to define equivalent universal languages (see [Turing degree](http://en.wikipedia.org/wiki/Turing_degree)).

Because Leibniz was a mathematical novice when he first wrote about the *characteristic*, at first he did not conceive it as an [algebra](http://en.wikipedia.org/wiki/Algebra) but rather as a [universal language](http://en.wikipedia.org/wiki/Universal_characteristic) or script. Only in 1676 did he conceive of a kind of "algebra of thought", modeled on and including conventional algebra and its notation. The resulting *characteristic* included a logical calculus, some combinatorics, algebra, his *analysis situs* (geometry of situation), a universal concept language, and more.

What Leibniz actually intended by his *characteristica universalis* and calculus ratiocinator, and the extent to which modern formal logic does justice to the calculus, may never be established.[[49]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-49)

**Formal logic**

*Main article:* [*Algebraic logic*](http://en.wikipedia.org/wiki/Algebraic_logic)

Leibniz is the most important logician between Aristotle and 1847, when [George Boole](http://en.wikipedia.org/wiki/George_Boole) and [Augustus De Morgan](http://en.wikipedia.org/wiki/Augustus_De_Morgan) each published books that began modern formal logic. Leibniz enunciated the principal properties of what we now call [conjunction](http://en.wikipedia.org/wiki/Logical_conjunction), [disjunction](http://en.wikipedia.org/wiki/Disjunction), [negation](http://en.wikipedia.org/wiki/Negation), [identity](http://en.wikipedia.org/wiki/Identity_(mathematics)), set [inclusion](http://en.wikipedia.org/wiki/Subset), and the [empty set](http://en.wikipedia.org/wiki/Empty_set). The principles of Leibniz's logic and, arguably, of his whole philosophy, reduce to two:

1. All our ideas are compounded from a very small number of simple ideas, which form the [alphabet of human thought](http://en.wikipedia.org/wiki/Alphabet_of_human_thought).
2. Complex ideas proceed from these simple ideas by a uniform and symmetrical combination, analogous to arithmetical multiplication.

The formal logic that emerged early in the 20th century also requires, at minimum, unary negation and [quantified](http://en.wikipedia.org/wiki/Quantification) [variables](http://en.wikipedia.org/wiki/Variable_(mathematics)) ranging over some [universe of discourse](http://en.wikipedia.org/wiki/Universe_of_discourse).

Leibniz published nothing on formal logic in his lifetime; most of what he wrote on the subject consists of working drafts. In his book [*History of Western Philosophy*](http://en.wikipedia.org/wiki/History_of_Western_Philosophy_(Russell)), [Bertrand Russell](http://en.wikipedia.org/wiki/Bertrand_Russell) went so far as to claim that Leibniz had developed logic in his unpublished writings to a level which was reached only 200 years later.

**Mathematician**

Although the mathematical notion of [function](http://en.wikipedia.org/wiki/Function_(mathematics)) was implicit in trigonometric and logarithmic tables, which existed in his day, Leibniz was the first, in 1692 and 1694, to employ it explicitly, to denote any of several geometric concepts derived from a curve, such as [abscissa](http://en.wikipedia.org/wiki/Abscissa), [ordinate](http://en.wikipedia.org/wiki/Ordinate), [tangent](http://en.wikipedia.org/wiki/Tangent), [chord](http://en.wikipedia.org/wiki/Chord_(geometry)), and the [perpendicular](http://en.wikipedia.org/wiki/Normal_(geometry)).[[50]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-50) In the 18th century, "function" lost these geometrical associations.

Leibniz was the first to see that the coefficients of a system of [linear equations](http://en.wikipedia.org/wiki/Linear_equation) could be arranged into an array, now called a [matrix](http://en.wikipedia.org/wiki/Matrix_(mathematics)), which can be manipulated to find the solution of the system, if any. This method was later called [Gaussian elimination](http://en.wikipedia.org/wiki/Gaussian_elimination). Leibniz's discoveries of [Boolean algebra](http://en.wikipedia.org/wiki/Boolean_algebra_(logic)) and of [symbolic logic](http://en.wikipedia.org/wiki/Mathematical_logic), also relevant to mathematics, are discussed in the preceding section. The best overview of Leibniz's writings on the calculus may be found in Bos (1974).[[51]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-Douglas_M._Jesseph.2C_1998-51)

**Calculus**

Leibniz is credited, along with Sir [Isaac Newton](http://en.wikipedia.org/wiki/Isaac_Newton), with the invention of [infinitesimal calculus](http://en.wikipedia.org/wiki/Infinitesimal_calculus) (that comprises differential and integral calculus). According to Leibniz's notebooks, a critical breakthrough occurred on November 11, 1675, when he employed integral calculus for the first time to find the area under the graph of a function *y* = *ƒ*(*x*). He introduced several notations used to this day, for instance the [integral sign](http://en.wikipedia.org/wiki/Integral_sign) ∫ representing an elongated S, from the Latin word *summa* and the *d* used for [differentials](http://en.wikipedia.org/wiki/Differential_(infinitesimal)), from the Latin word *differentia*. This cleverly suggestive notation for the calculus is probably his most enduring mathematical legacy. Leibniz did not publish anything about his calculus until 1684.[[52]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-52) The [product rule](http://en.wikipedia.org/wiki/Product_rule) of [differential calculus](http://en.wikipedia.org/wiki/Differential_calculus) is still called "Leibniz's law". In addition, the theorem that tells how and when to differentiate under the integral sign is called the [Leibniz integral rule](http://en.wikipedia.org/wiki/Leibniz_integral_rule).

Leibniz exploited [infinitesimals](http://en.wikipedia.org/wiki/Infinitesimal) in developing the calculus, manipulating them in ways suggesting that they had [paradoxical](http://en.wikipedia.org/wiki/Paradox) [algebraic](http://en.wikipedia.org/wiki/Algebra) properties. [George Berkeley](http://en.wikipedia.org/wiki/George_Berkeley), in a tract called [*The Analyst*](http://en.wikipedia.org/wiki/The_Analyst) and also in *De Motu*, criticized these. A recent study argues that Leibnizian calculus was free of contradictions, and was better grounded than Berkeley's empiricist criticisms.[[53]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-53)

From 1711 until his death, Leibniz was engaged in a dispute with John Keill, Newton and others, over whether Leibniz had invented the calculus independently of Newton. This subject is treated at length in the article [Leibniz-Newton controversy](http://en.wikipedia.org/wiki/Leibniz-Newton_controversy).

Infinitesimals were officially banned from mathematics by the followers of [Karl Weierstrass](http://en.wikipedia.org/wiki/Karl_Weierstrass), but survived in science and engineering, and even in rigorous mathematics, via the fundamental computational device known as the [differential](http://en.wikipedia.org/wiki/Differential_(mathematics)). Beginning in 1960, [Abraham Robinson](http://en.wikipedia.org/wiki/Abraham_Robinson) worked out a rigorous foundation for Leibniz's infinitesimals, using [model theory](http://en.wikipedia.org/wiki/Model_theory), in the context of a field of [hyperreal numbers](http://en.wikipedia.org/wiki/Hyperreal_number). The resulting [non-standard analysis](http://en.wikipedia.org/wiki/Non-standard_analysis) can be seen as a belated vindication of Leibniz's mathematical reasoning. Robinson's [transfer principle](http://en.wikipedia.org/wiki/Transfer_principle) is a mathematical implementation of Leibniz's heuristic [law of continuity](http://en.wikipedia.org/wiki/Law_of_continuity).

**Topology**

Leibniz was the first to use the term *analysis situs*,[[54]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-54) later used in the 19th century to refer to what is now known as [topology](http://en.wikipedia.org/wiki/Topology). There are two takes on this situation. On the one hand, Mates, citing a 1954 paper in German by [Jacob Freudenthal](http://en.wikipedia.org/wiki/Jacob_Freudenthal), argues:

Although for Leibniz the situs of a sequence of points is completely determined by the distance between them and is altered if those distances are altered, his admirer [Euler](http://en.wikipedia.org/wiki/Euler), in the famous 1736 paper solving the [Königsberg Bridge Problem](http://en.wikipedia.org/wiki/Seven_Bridges_of_K%C3%B6nigsberg) and its generalizations, used the term *geometria situs* in such a sense that the situs remains unchanged under topological deformations. He mistakenly credits Leibniz with originating this concept. ...it is sometimes not realized that Leibniz used the term in an entirely different sense and hence can hardly be considered the founder of that part of mathematics.[[55]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-55)

But [Hideaki Hirano](http://en.wikipedia.org/w/index.php?title=Hideaki_Hirano&action=edit&redlink=1) argues differently, quoting [Mandelbrot](http://en.wikipedia.org/wiki/Beno%C3%AEt_Mandelbrot):[[56]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-56)

To sample Leibniz' scientific works is a sobering experience. Next to calculus, and to other thoughts that have been carried out to completion, the number and variety of premonitory thrusts is overwhelming. We saw examples in 'packing,'... My Leibniz mania is further reinforced by finding that for one moment its hero attached importance to geometric scaling. In "Euclidis Prota"..., which is an attempt to tighten Euclid's axioms, he states,...: 'I have diverse definitions for the straight line. The straight line is a curve, any part of which is similar to the whole, and it alone has this property, not only among curves but among sets.' This claim can be proved today.[[57]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-57)

Thus the [fractal geometry](http://en.wikipedia.org/wiki/Fractal) promoted by Mandelbrot drew on Leibniz's notions of [self-similarity](http://en.wikipedia.org/wiki/Self-similarity) and the principle of continuity: [natura non facit saltus](http://en.wikipedia.org/wiki/Natura_non_facit_saltus). We also see that when Leibniz wrote, in a metaphysical vein, that "the straight line is a curve, any part of which is similar to the whole", he was anticipating topology by more than two centuries. As for "packing", Leibniz told to his friend and correspondent Des Bosses to imagine a circle, then to inscribe within it three congruent circles with maximum radius; the latter smaller circles could be filled with three even smaller circles by the same procedure. This process can be continued infinitely, from which arises a good idea of self-similarity. Leibniz's improvement of Euclid's axiom contains the same concept.

**Scientist and engineer**

Leibniz's writings are currently discussed, not only for their anticipations and possible discoveries not yet recognized, but as ways of advancing present knowledge. Much of his writing on physics is included in Gerhardt's *Mathematical Writings*.

**Physics**

*See also:* [*Dynamism (metaphysics)*](http://en.wikipedia.org/wiki/Dynamism_(metaphysics))

Leibniz contributed a fair amount to the statics and dynamics emerging about him, often disagreeing with [Descartes](http://en.wikipedia.org/wiki/Descartes) and [Newton](http://en.wikipedia.org/wiki/Isaac_Newton). He devised a new theory of [motion](http://en.wikipedia.org/wiki/Motion_(physics)) ([dynamics](http://en.wikipedia.org/wiki/Dynamics_(mechanics))) based on [kinetic energy](http://en.wikipedia.org/wiki/Kinetic_energy) and [potential energy](http://en.wikipedia.org/wiki/Potential_energy), which posited space as relative, whereas Newton was thoroughly convinced that space was absolute. An important example of Leibniz's mature physical thinking is his *Specimen Dynamicum* of 1695.[[58]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-58)

Until the discovery of subatomic particles and the [quantum mechanics](http://en.wikipedia.org/wiki/Quantum_mechanics) governing them, many of Leibniz's speculative ideas about aspects of nature not reducible to statics and dynamics made little sense. For instance, he anticipated [Albert Einstein](http://en.wikipedia.org/wiki/Albert_Einstein) by arguing, against Newton, that [space](http://en.wikipedia.org/wiki/Space), [time](http://en.wikipedia.org/wiki/Time) and motion are relative, not absolute.[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed)] [Leibniz's rule](http://en.wikipedia.org/wiki/Leibniz%27s_rule) is an important, if often overlooked, step in many proofs in diverse fields of physics. The [principle of sufficient reason](http://en.wikipedia.org/wiki/Principle_of_sufficient_reason) has been invoked in recent [cosmology](http://en.wikipedia.org/wiki/Cosmology), and his [identity of indiscernibles](http://en.wikipedia.org/wiki/Identity_of_indiscernibles) in quantum mechanics, a field some even credit him with having anticipated in some sense. Those who advocate [digital philosophy](http://en.wikipedia.org/wiki/Digital_philosophy), a recent direction in cosmology, claim Leibniz as a precursor.

**The *vis viva***

Leibniz's [*vis viva*](http://en.wikipedia.org/wiki/Vis_viva) (Latin for *living force*) is *mv*2, twice the modern [kinetic energy](http://en.wikipedia.org/wiki/Kinetic_energy). He realized that the total energy would be conserved in certain mechanical systems, so he considered it an innate motive characteristic of matter.[[59]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-59) Here too his thinking gave rise to another regrettable nationalistic dispute. His *vis viva* was seen as rivaling the [conservation of momentum](http://en.wikipedia.org/wiki/Conservation_of_momentum) championed by Newton in England and by [Descartes](http://en.wikipedia.org/wiki/Descartes) in France; hence [academics](http://en.wikipedia.org/wiki/Academics) in those countries tended to neglect Leibniz's idea. In reality, both [energy](http://en.wikipedia.org/wiki/Energy) and [momentum](http://en.wikipedia.org/wiki/Momentum) are conserved, so the two approaches are equally valid.

**Other natural science**

By proposing that the earth has a molten core, he anticipated modern [geology](http://en.wikipedia.org/wiki/Geology). In [embryology](http://en.wikipedia.org/wiki/Embryology), he was a preformationist, but also proposed that organisms are the outcome of a combination of an infinite number of possible microstructures and of their powers. In the [life sciences](http://en.wikipedia.org/wiki/Life_sciences) and [paleontology](http://en.wikipedia.org/wiki/Paleontology), he revealed an amazing transformist intuition, fueled by his study of comparative anatomy and fossils. One of his principal works on this subject, *Protogaea*, unpublished in his lifetime, has recently been published in English for the first time. He worked out a primal [organismic theory](http://en.wikipedia.org/wiki/Organismic_theory).[[60]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-60) In medicine, he exhorted the physicians of his time—with some results—to ground their theories in detailed comparative observations and verified experiments, and to distinguish firmly scientific and metaphysical points of view.

**Social science**

In [psychology](http://en.wikipedia.org/wiki/Psychology),[[61]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-61) he anticipated the distinction between [conscious](http://en.wikipedia.org/wiki/Conscious) and [unconscious](http://en.wikipedia.org/wiki/Unconscious_mind) states. In public health, he advocated establishing a medical administrative authority, with powers over [epidemiology](http://en.wikipedia.org/wiki/Epidemiology) and [veterinary medicine](http://en.wikipedia.org/wiki/Veterinary_medicine). He worked to set up a coherent medical training programme, oriented towards public health and preventive measures. In economic policy, he proposed tax reforms and a national insurance program, and discussed the [balance of trade](http://en.wikipedia.org/wiki/Balance_of_trade). He even proposed something akin to what much later emerged as [game theory](http://en.wikipedia.org/wiki/Game_theory). In [sociology](http://en.wikipedia.org/wiki/Sociology) he laid the ground for [communication theory](http://en.wikipedia.org/wiki/Communication_theory).

**Technology**

In 1906, Garland published a volume of Leibniz's writings bearing on his many practical inventions and engineering work. To date, few of these writings have been translated into English. Nevertheless, it is well understood that Leibniz was a serious inventor, engineer, and applied scientist, with great respect for practical life. Following the motto *theoria cum praxis*, he urged that theory be combined with practical application, and thus has been claimed as the father of [applied science](http://en.wikipedia.org/wiki/Applied_science). He designed wind-driven propellers and water pumps, mining machines to extract ore, hydraulic presses, lamps, submarines, clocks, etc. With [Denis Papin](http://en.wikipedia.org/wiki/Denis_Papin), he invented a [steam engine](http://en.wikipedia.org/wiki/Steam_engine). He even proposed a method for desalinating water. From 1680 to 1685, he struggled to overcome the chronic flooding that afflicted the ducal [silver](http://en.wikipedia.org/wiki/Silver) mines in the [Harz Mountains](http://en.wikipedia.org/wiki/Harz_Mountains), but did not succeed.[[62]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-62)

**Computation**

Leibniz may have been the first computer scientist and information theorist.[[63]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-63) Early in life, he documented the [binary numeral system](http://en.wikipedia.org/wiki/Binary_numeral_system) ([base](http://en.wikipedia.org/wiki/Radix) 2), then revisited that system throughout his career.[[64]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-64) He anticipated [Lagrangian interpolation](http://en.wikipedia.org/wiki/Lagrange_polynomial) and [algorithmic information theory](http://en.wikipedia.org/wiki/Algorithmic_information_theory). His [calculus ratiocinator](http://en.wikipedia.org/wiki/Calculus_ratiocinator) anticipated aspects of the [universal Turing machine](http://en.wikipedia.org/wiki/Universal_Turing_machine). In 1934, [Norbert Wiener](http://en.wikipedia.org/wiki/Norbert_Wiener) claimed to have found in Leibniz's writings a mention of the concept of [feedback](http://en.wikipedia.org/wiki/Feedback), central to Wiener's later [cybernetic](http://en.wikipedia.org/wiki/Cybernetics) theory.

In 1671, Leibniz began to invent a machine that could execute all four arithmetical operations, gradually improving it over a number of years. This "[Stepped Reckoner](http://en.wikipedia.org/wiki/Stepped_Reckoner)" attracted fair attention and was the basis of his election to the [Royal Society](http://en.wikipedia.org/wiki/Royal_Society) in 1673. A number of such machines were made during his years in [Hanover](http://en.wikipedia.org/wiki/Hanover), by a craftsman working under Leibniz's supervision. It was not an unambiguous success because it did not fully mechanize the operation of carrying. Couturat reported finding an unpublished note by Leibniz, dated 1674, describing a machine capable of performing some algebraic operations.[[65]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-65)

Leibniz was groping towards hardware and software concepts worked out much later by [Charles Babbage](http://en.wikipedia.org/wiki/Charles_Babbage) and [Ada Lovelace](http://en.wikipedia.org/wiki/Ada_Lovelace). In 1679, while mulling over his binary arithmetic, Leibniz imagined a machine in which binary numbers were represented by marbles, governed by a rudimentary sort of punched cards.[[66]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-66) Modern electronic digital computers replace Leibniz's marbles moving by gravity with shift registers, voltage gradients, and pulses of electrons, but otherwise they run roughly as Leibniz envisioned in 1679.

**Librarian**

While serving as librarian of the ducal libraries in [Hanover](http://en.wikipedia.org/wiki/Hanover) and [Wolfenbuettel](http://en.wikipedia.org/wiki/Wolfenbuettel), Leibniz effectively became one of the founders of [library science](http://en.wikipedia.org/wiki/Library_science). The latter library was enormous for its day, as it contained more than 100,000 volumes, and Leibniz helped design a new building for it, believed to be the first building explicitly designed to be a library. He also designed a book [indexing system](http://en.wikipedia.org/wiki/Library_classification) in ignorance of the only other such system then extant, that of the [Bodleian Library](http://en.wikipedia.org/wiki/Bodleian_Library) at [Oxford University](http://en.wikipedia.org/wiki/Oxford_University). He also called on publishers to distribute abstracts of all new titles they produced each year, in a standard form that would facilitate indexing. He hoped that this abstracting project would eventually include everything printed from his day back to [Gutenberg](http://en.wikipedia.org/wiki/Johannes_Gutenberg). Neither proposal met with success at the time, but something like them became standard practice among English language publishers during the 20th century, under the aegis of the [Library of Congress](http://en.wikipedia.org/wiki/Library_of_Congress) and the [British Library](http://en.wikipedia.org/wiki/British_Library).

He called for the creation of an [empirical](http://en.wikipedia.org/wiki/Empirical) [database](http://en.wikipedia.org/wiki/Database) as a way to further all sciences. His [*characteristica universalis*](http://en.wikipedia.org/wiki/Characteristica_universalis), [calculus ratiocinator](http://en.wikipedia.org/wiki/Calculus_ratiocinator), and a "community of minds"—intended, among other things, to bring political and religious unity to Europe—can be seen as distant unwitting anticipations of artificial languages (e.g., [Esperanto](http://en.wikipedia.org/wiki/Esperanto) and its rivals), [symbolic logic](http://en.wikipedia.org/wiki/Mathematical_logic), even the [World Wide Web](http://en.wikipedia.org/wiki/World_Wide_Web).

**Advocate of scientific societies**

Leibniz emphasized that [research](http://en.wikipedia.org/wiki/Research) was a collaborative endeavor. Hence he warmly advocated the formation of national scientific societies along the lines of the British Royal Society and the French Academie Royale des Sciences. More specifically, in his correspondence and travels he urged the creation of such societies in Dresden, Saint Petersburg, Vienna, and Berlin. Only one such project came to fruition; in 1700, the [Berlin Academy of Sciences](http://en.wikipedia.org/wiki/Prussian_Academy_of_Sciences) was created. Leibniz drew up its first statutes, and served as its first President for the remainder of his life. That Academy evolved into the German Academy of Sciences, the publisher of the ongoing critical edition of his works.[[67]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-67)

**Lawyer, moralist**

With the possible exception of [Marcus Aurelius](http://en.wikipedia.org/wiki/Marcus_Aurelius), no philosopher has ever had as much experience with practical affairs of state as Leibniz. Leibniz's writings on law, ethics, and politics[[68]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-68) were long overlooked by English-speaking scholars, but this has changed of late.[[69]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-69)

While Leibniz was no apologist for [absolute monarchy](http://en.wikipedia.org/wiki/Absolute_monarchy) like [Hobbes](http://en.wikipedia.org/wiki/Hobbes), or for tyranny in any form, neither did he echo the political and constitutional views of his contemporary [John Locke](http://en.wikipedia.org/wiki/John_Locke), views invoked in support of democracy, in 18th-century America and later elsewhere. The following excerpt from a 1695 letter to Baron J. C. Boyneburg's son Philipp is very revealing of Leibniz's political sentiments:

As for.. the great question of the power of sovereigns and the obedience their peoples owe them, I usually say that it would be good for princes to be persuaded that their people have the right to resist them, and for the people, on the other hand, to be persuaded to obey them passively. I am, however, quite of the opinion of [Grotius](http://en.wikipedia.org/wiki/Grotius), that one ought to obey as a rule, the evil of revolution being greater beyond comparison than the evils causing it. Yet I recognize that a prince can go to such excess, and place the well-being of the state in such danger, that the obligation to endure ceases. This is most rare, however, and the theologian who authorizes violence under this pretext should take care against excess; excess being infinitely more dangerous than deficiency.[[70]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-70)

In 1677, Leibniz called for a European confederation, governed by a council or senate, whose members would represent entire nations and would be free to vote their consciences;[[71]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-71) this is sometimes tendentiously considered an anticipation of the [European Union](http://en.wikipedia.org/wiki/European_Union). He believed that Europe would adopt a uniform religion. He reiterated these proposals in 1715.

**Ecumenism**

Leibniz devoted considerable intellectual and diplomatic effort to what would now be called [ecumenical](http://en.wikipedia.org/wiki/Ecumenism) endeavor, seeking to reconcile first the [Roman Catholic](http://en.wikipedia.org/wiki/Roman_Catholic) and [Lutheran](http://en.wikipedia.org/wiki/Lutheran) churches, later the Lutheran and [Reformed](http://en.wikipedia.org/wiki/Reformed) churches. In this respect, he followed the example of his early patrons, Baron von Boyneburg and the Duke [John Frederick](http://en.wikipedia.org/wiki/John_Frederick,_Duke_of_Brunswick-L%C3%BCneburg)—both cradle Lutherans who converted to Catholicism as adults—who did what they could to encourage the reunion of the two faiths, and who warmly welcomed such endeavors by others. (The House of [Brunswick](http://en.wikipedia.org/wiki/Brunswick-L%C3%BCneburg) remained Lutheran because the Duke's children did not follow their father.) These efforts included corresponding with the French bishop [Jacques-Bénigne Bossuet](http://en.wikipedia.org/wiki/Jacques-B%C3%A9nigne_Bossuet), and involved Leibniz in a fair bit of theological controversy. He evidently thought that the thoroughgoing application of reason would suffice to heal the breach caused by the [Reformation](http://en.wikipedia.org/wiki/Protestant_Reformation).

**Philologist**

Leibniz the [philologist](http://en.wikipedia.org/wiki/Philologist) was an avid student of languages, eagerly latching on to any information about vocabulary and grammar that came his way. He refuted the belief, widely held by Christian scholars in his day, that [Hebrew](http://en.wikipedia.org/wiki/Hebrew_language) was the primeval language of the human race. He also refuted the argument, advanced by Swedish scholars in his day, that a form of proto-[Swedish](http://en.wikipedia.org/wiki/Swedish_language) was the ancestor of the [Germanic languages](http://en.wikipedia.org/wiki/Germanic_languages). He puzzled over the origins of the [Slavic languages](http://en.wikipedia.org/wiki/Slavic_languages), was aware of the existence of [Sanskrit](http://en.wikipedia.org/wiki/Sanskrit), and was fascinated by [classical Chinese](http://en.wikipedia.org/wiki/Classical_Chinese).

He published the *princeps editio* (first modern edition) of the [late medieval](http://en.wikipedia.org/wiki/Late_Middle_Ages) [*Chronicon Holtzatiae*](http://en.wikipedia.org/wiki/Chronicon_Holtzatiae), a Latin chronicle of the [County of Holstein](http://en.wikipedia.org/wiki/County_of_Holstein).

**Sinophile**

Leibniz was perhaps the first major European intellect to take a close interest in [Chinese](http://en.wikipedia.org/wiki/China) civilization, which he knew by corresponding with, and reading other works by, European Christian missionaries posted in China. Having read *Confucius Sinicus Philosophus* on the first year of its publication,[[72]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-Mungello-72) he concluded that Europeans could learn much from the [Confucian](http://en.wikipedia.org/wiki/Confucianism) ethical tradition. He mulled over the possibility that the [Chinese characters](http://en.wikipedia.org/wiki/Chinese_character) were an unwitting form of his [universal characteristic](http://en.wikipedia.org/wiki/Characteristica_universalis). He noted with fascination how the [*I Ching*](http://en.wikipedia.org/wiki/I_Ching) hexagrams correspond to the [binary numbers](http://en.wikipedia.org/wiki/Binary_numbers) from 0 to 111111, and concluded that this mapping was evidence of major Chinese accomplishments in the sort of philosophical mathematics he admired.[[73]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-73)

Leibniz's attraction to [Chinese philosophy](http://en.wikipedia.org/wiki/Chinese_philosophy) originates from his perception that Chinese philosophy was similar to his own.[[72]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-Mungello-72) The historian E.R. Hughes suggests that Leibniz's ideas of "simple substance" and "pre-established harmony" were directly influenced by [Confucianism](http://en.wikipedia.org/wiki/Confucianism), pointing to the fact that they were conceived during the period that he was reading *Confucius Sinicus Philosophus*.[[72]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-Mungello-72)

**As polymath**

While making his grand tour of European archives to research the Brunswick family history that he never completed, Leibniz stopped in [Vienna](http://en.wikipedia.org/wiki/Vienna) between May 1688 and February 1689, where he did much legal and diplomatic work for the Brunswicks. He visited mines, talked with mine engineers, and tried to negotiate export contracts for lead from the ducal mines in the [Harz mountains](http://en.wikipedia.org/wiki/Harz_mountains). His proposal that the streets of Vienna be lit with lamps burning [rapeseed oil](http://en.wikipedia.org/wiki/Rapeseed_oil) was implemented. During a formal audience with the [Austrian Emperor](http://en.wikipedia.org/wiki/Holy_Roman_Emperor) and in subsequent memoranda, he advocated reorganizing the Austrian economy, reforming the coinage of much of central Europe, negotiating a [Concordat](http://en.wikipedia.org/wiki/Concordat) between the [Habsburgs](http://en.wikipedia.org/wiki/Habsburg) and the [Vatican](http://en.wikipedia.org/wiki/Holy_See), and creating an imperial research library, official archive, and public insurance fund. He wrote and published an important paper on [mechanics](http://en.wikipedia.org/wiki/Mechanics).

Leibniz also wrote a short paper, first published by [Louis Couturat](http://en.wikipedia.org/wiki/Louis_Couturat) in 1903,[[74]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-74) summarizing his views on [metaphysics](http://en.wikipedia.org/wiki/Metaphysics). The paper is undated; that he wrote it while in Vienna was determined only in 1999, when the ongoing critical edition finally published Leibniz's philosophical writings for the period 1677–90. Couturat's reading of this paper was the launching point for much 20th-century thinking about Leibniz, especially among [analytic philosophers](http://en.wikipedia.org/wiki/Analytic_philosophy). But after a meticulous study of all of Leibniz's philosophical writings up to 1688—a study the 1999 additions to the critical edition made possible—Mercer (2001) begged to differ with Couturat's reading; the jury is still out.

**Posthumous reputation**

**As a mathematician and philosopher**

When Leibniz died, his reputation was in decline. He was remembered for only one book, the [*Théodicée*](http://en.wikipedia.org/wiki/Th%C3%A9odic%C3%A9e), whose supposed central argument [Voltaire](http://en.wikipedia.org/wiki/Voltaire) lampooned in his [*Candide*](http://en.wikipedia.org/wiki/Candide). Voltaire's depiction of Leibniz's ideas was so influential that many believed it to be an accurate description. Thus Voltaire and his *Candide* bear some of the blame for the lingering failure to appreciate and understand Leibniz's ideas. Leibniz had an ardent disciple, [Christian Wolff](http://en.wikipedia.org/wiki/Christian_Wolff_(philosopher)), whose dogmatic and facile outlook did Leibniz's reputation much harm. He also influenced [David Hume](http://en.wikipedia.org/wiki/David_Hume) who read his [*Théodicée*](http://en.wikipedia.org/wiki/Th%C3%A9odic%C3%A9e) and used some of his ideas.[[75]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-75) In any event, philosophical fashion was moving away from the rationalism and system building of the 17th century, of which Leibniz had been such an ardent proponent. His work on law, diplomacy, and history was seen as of ephemeral interest. The vastness and richness of his correspondence went unrecognized.

Much of Europe came to doubt that Leibniz had discovered the calculus independently of Newton, and hence his whole work in mathematics and physics was neglected. Voltaire, an admirer of Newton, also wrote *Candide* at least in part to discredit Leibniz's claim to having discovered the calculus and Leibniz's charge that Newton's theory of universal gravitation was incorrect.[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed)] The rise of relativity and subsequent work in the history of mathematics has put Leibniz's stance in a more favorable light.

Leibniz's long march to his present glory began with the 1765 publication of the *Nouveaux Essais*, which [Kant](http://en.wikipedia.org/wiki/Kant) read closely. In 1768, Dutens edited the first multi-volume edition of Leibniz's writings, followed in the 19th century by a number of editions, including those edited by Erdmann, Foucher de Careil, Gerhardt, Gerland, Klopp, and Mollat. Publication of Leibniz's correspondence with notables such as [Antoine Arnauld](http://en.wikipedia.org/wiki/Antoine_Arnauld), [Samuel Clarke](http://en.wikipedia.org/wiki/Samuel_Clarke), [Sophia of Hanover](http://en.wikipedia.org/wiki/Sophia_of_Hanover), and her daughter [Sophia Charlotte of Hanover](http://en.wikipedia.org/wiki/Sophia_Charlotte_of_Hanover), began.

In 1900, [Bertrand Russell](http://en.wikipedia.org/wiki/Bertrand_Russell) published a critical study of Leibniz's [metaphysics](http://en.wikipedia.org/wiki/Metaphysics).[[76]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-76) Shortly thereafter, [Louis Couturat](http://en.wikipedia.org/wiki/Louis_Couturat) published an important study of Leibniz, and edited a volume of Leibniz's heretofore unpublished writings, mainly on logic. They made Leibniz somewhat respectable among 20th-century [analytical](http://en.wikipedia.org/wiki/Analytic_philosophy) and [linguistic](http://en.wikipedia.org/wiki/Linguistic_philosophy) philosophers in the English-speaking world (Leibniz had already been of great influence to many Germans such as [Bernhard Riemann](http://en.wikipedia.org/wiki/Bernhard_Riemann)). For example, Leibniz's phrase [*salva veritate*](http://en.wikipedia.org/wiki/Salva_veritate), meaning interchangeability without loss of or compromising the truth, recurs in [Willard Quine](http://en.wikipedia.org/wiki/Willard_Quine)'s writings. Nevertheless, the secondary English-language literature on Leibniz did not really blossom until after World War II. This is especially true of English speaking countries; in Gregory Brown's bibliography fewer than 30 of the English language entries were published before 1946. American Leibniz studies owe much to [Leroy Loemker](http://en.wikipedia.org/w/index.php?title=Leroy_Loemker&action=edit&redlink=1) (1904–85) through his translations and his interpretive essays in LeClerc (1973).

[Nicholas Jolley](http://en.wikipedia.org/w/index.php?title=Nicholas_Jolley&action=edit&redlink=1) has surmised that Leibniz's reputation as a philosopher is now perhaps higher than at any time since he was alive.[[77]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-77) Analytic and contemporary philosophy continue to invoke his notions of [identity](http://en.wikipedia.org/wiki/Identity_(philosophy)), [individuation](http://en.wikipedia.org/wiki/Principle_of_individuation), and [possible worlds](http://en.wikipedia.org/wiki/Possible_worlds), while the doctrinaire contempt for metaphysics, characteristic of analytic and linguistic philosophy, has faded[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]. Work in the history of 17th- and 18th-century [ideas](http://en.wikipedia.org/wiki/History_of_ideas) has revealed more clearly the 17th-century "Intellectual Revolution" that preceded the better-known [Industrial](http://en.wikipedia.org/wiki/Industrial_revolution) and commercial revolutions of the 18th and 19th centuries. The 17th- and 18th-century belief that natural science, especially physics, differs from philosophy mainly in degree and not in kind, is no longer dismissed out of hand. That modern science includes a "[scholastic](http://en.wikipedia.org/wiki/Scholasticism)" as well as a "radical [empiricist](http://en.wikipedia.org/wiki/Empiricist)" element is more accepted now than in the early 20th century. Leibniz's thought is now seen as a major prolongation of the mighty endeavor begun by [Plato](http://en.wikipedia.org/wiki/Plato) and [Aristotle](http://en.wikipedia.org/wiki/Aristotle): the universe and man's place in it are amenable to human [reason](http://en.wikipedia.org/wiki/Reason).

In 1985, the German government created the [Leibniz Prize](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz_Prize), offering an annual award of 1.55 million [euros](http://en.wikipedia.org/wiki/Euro) for experimental results and 770,000 euros for theoretical ones. It is the world's largest prize for scientific achievement.

The collection of manuscript papers of Leibniz at the Gottfried Wilhelm Leibniz Bibliothek – Niedersächische Landesbibliothek were inscribed on [UNESCO](http://en.wikipedia.org/wiki/UNESCO)'s [Memory of the World Register](http://en.wikipedia.org/wiki/Memory_of_the_World_Register) in 2007.[[78]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-mow-78)

**Leibniz biscuits**

[Leibniz-Keks](http://en.wikipedia.org/wiki/Leibniz-Keks), a popular brand of biscuits, are named after Gottfried Leibniz. These biscuits honour Leibniz because he was a resident of Hanover, where the company is based.[[79]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-79)

**Writings and edition**

Leibniz mainly wrote in three languages: scholastic [Latin](http://en.wikipedia.org/wiki/Latin), [French](http://en.wikipedia.org/wiki/French_language) and [German](http://en.wikipedia.org/wiki/German_language). During his lifetime, he published many pamphlets and scholarly articles, but only two "philosophical" books, the *Combinatorial Art* and the [*Théodicée*](http://en.wikipedia.org/wiki/Th%C3%A9odic%C3%A9e). (He published numerous pamphlets, often anonymous, on behalf of the House of [Brunswick-Lüneburg](http://en.wikipedia.org/wiki/Brunswick-L%C3%BCneburg), most notably the "De jure suprematum" a major consideration of the nature of [sovereignty](http://en.wikipedia.org/wiki/Sovereignty).) One substantial book appeared posthumously, his [*Nouveaux essais sur l'entendement humain*](http://en.wikipedia.org/wiki/Nouveaux_essais_sur_l%27entendement_humain), which Leibniz had withheld from publication after the death of [John Locke](http://en.wikipedia.org/wiki/John_Locke). Only in 1895, when Bodemann completed his catalogues of Leibniz's manuscripts and correspondence, did the enormous extent of Leibniz's [*Nachlass*](http://en.wikipedia.org/wiki/Nachlass) become clear: about 15,000 letters to more than 1000 recipients plus more than 40,000 other items. Moreover, quite a few of these letters are of essay length. Much of his vast correspondence, especially the letters dated after 1685, remains unpublished, and much of what is published has been so only in recent decades. The amount, variety, and disorder of Leibniz's writings are a predictable result of a situation he described in a letter as follows:

I cannot tell you how extraordinarily distracted and spread out I am. I am trying to find various things in the archives; I look at old papers and hunt up unpublished documents. From these I hope to shed some light on the history of the [House of] Brunswick. I receive and answer a huge number of letters. At the same time, I have so many mathematical results, philosophical thoughts, and other literary innovations that should not be allowed to vanish that I often do not know where to begin.[[80]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-80)

The extant parts of the critical edition[[81]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-ce-81) of Leibniz's writings are organized as follows:

* Series 1. *Political, Historical, and General Correspondence*. 21 vols., 1666–1701.
* Series 2. *Philosophical Correspondence*. 1 vol., 1663–85.
* Series 3. *Mathematical, Scientific, and Technical Correspondence*. 6 vols., 1672–96.
* Series 4. *Political Writings*. 6 vols., 1667–98.
* Series 5. *Historical and Linguistic Writings*. Inactive.
* Series 6. *Philosophical Writings*. 7 vols., 1663–90, and *Nouveaux essais sur l'entendement humain*.
* Series 7. *Mathematical Writings*. 3 vols., 1672–76.
* Series 8. *Scientific, Medical, and Technical Writings*. In preparation.

The systematic cataloguing of all of Leibniz's *Nachlass* began in 1901. It was hampered by two world wars, the Nazi dictatorship (with the Holocaust, which affected a Jewish employee of the project, and other personal consequences), and decades of German division (two states with the cold war's "iron curtain" in between, separating scholars and also scattering portions of his literary estates). The ambitious project has had to deal with seven languages contained in some 200,000 pages of written and printed paper. In 1985 it was reorganized and included in a joint program of German federal and state (*Länder*) academies. Since then the branches in [Potsdam](http://en.wikipedia.org/wiki/Potsdam), [Münster](http://en.wikipedia.org/wiki/M%C3%BCnster), [Hanover](http://en.wikipedia.org/wiki/Hanover) and [Berlin](http://en.wikipedia.org/wiki/Berlin) have jointly published 25 volumes of the critical edition, with an average of 870 pages, and prepared index and [concordance](http://en.wikipedia.org/wiki/Concordance_(publishing)) works.

**Selected works**

The year given is usually that in which the work was completed, not of its eventual publication.

* 1666. [*De Arte Combinatoria*](http://en.wikipedia.org/wiki/De_Arte_Combinatoria) (*On the Art of Combination*); partially translated in Loemker §1 and Parkinson (1966).
* 1671. *Hypothesis Physica Nova* (*New Physical Hypothesis*); Loemker §8.I (partial).
* 1673 [*Confessio philosophi*](http://en.wikisource.org/wiki/la:Confessio_philosophi) (*A Philosopher's Creed*); an [English translation](http://en.wikisource.org/wiki/Confessio_philosophi) is available.
* 1684. *Nova methodus pro maximis et minimis* (*New method for maximums and minimums*); translated in Struik, D. J., 1969. *A Source Book in Mathematics, 1200–1800*. Harvard University Press: 271–81.
* 1686. [*Discours de métaphysique*](http://en.wikipedia.org/wiki/Discourse_on_Metaphysics_(book)); Martin and Brown (1988), Ariew and Garber 35, Loemker §35, Wiener III.3, Woolhouse and Francks 1. An [online translation](http://www.earlymoderntexts.com) by Jonathan Bennett is available.
* 1703. *Explication de l'Arithmétique Binaire* (*Explanation of Binary Arithmetic*); Gerhardt, *Mathematical Writings* VII.223. An [online translation](http://www.leibniz-translations.com/binary.htm) by Lloyd Strickland is available.
* 1710. [*Théodicée*](http://en.wikipedia.org/wiki/Th%C3%A9odic%C3%A9e); Farrer, A.M., and Huggard, E.M., trans., 1985 (1952). Wiener III.11 (part). An [online translation](http://www.gutenberg.org/etext/17147) is available at [Project Gutenberg](http://en.wikipedia.org/wiki/Project_Gutenberg).
* 1714. [*Monadologie*](http://en.wikipedia.org/wiki/Monadologie); translated by [Nicholas Rescher](http://en.wikipedia.org/wiki/Nicholas_Rescher), 1991. *The Monadology: An Edition for Students*. University of Pittsburg Press. Ariew and Garber 213, Loemker §67, Wiener III.13, Woolhouse and Francks 19. Online translations: [Jonathan Bennett's translation](http://www.earlymoderntexts.com); [Latta's translation](http://www.rbjones.com/rbjpub/philos/classics/leibniz/monad.htm); [French, Latin and Spanish edition, with facsimile of Leibniz's manuscript.](http://www.helicon.es/dig/8542205.pdf)
* 1765. [*Nouveaux essais sur l'entendement humain*](http://en.wikipedia.org/wiki/Nouveaux_essais_sur_l%27entendement_humain); completed in 1704. Remnant, Peter, and Bennett, Jonathan, trans., 1996. *New Essays on Human Understanding*. Cambridge University Press. Wiener III.6 (part). An [online translation](http://www.earlymoderntexts.com/f_leibniz.html) by Jonathan Bennett is available.

**Collections**

Five important collections of English translations are Wiener (1951), Loemker (1969), Ariew and Garber (1989), Woolhouse and Francks (1998), and Strickland (2006). The ongoing critical edition of all of Leibniz's writings is *Sämtliche Schriften und Briefe*.[[81]](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_note-ce-81)

**See also**

* [General Leibniz rule](http://en.wikipedia.org/wiki/General_Leibniz_rule)
* [German inventors and discoverers](http://en.wikipedia.org/wiki/German_inventors_and_discoverers)
* [Gottfried Wilhelm Leibniz Scientific Community](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz_Scientific_Community)
* [Gottfried Wilhelm Leibniz Universität Hannover](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz_Universit%C3%A4t_Hannover)
* [Leibniz formula for π](http://en.wikipedia.org/wiki/Leibniz_formula_for_%CF%80)
* [Leibniz formula for determinants](http://en.wikipedia.org/wiki/Leibniz_formula_for_determinants)
* [Leibniz harmonic triangle](http://en.wikipedia.org/wiki/Leibniz_harmonic_triangle)
* [Leibniz integral rule](http://en.wikipedia.org/wiki/Leibniz_integral_rule) for differentiation under the integral sign
* [Leibniz test](http://en.wikipedia.org/wiki/Leibniz_test)
* [Leibniz's notation](http://en.wikipedia.org/wiki/Leibniz%27s_notation)
* [Leibniz operator](http://en.wikipedia.org/wiki/Leibniz_operator)
* [Leibniz–Clarke correspondence](http://en.wikipedia.org/wiki/Leibniz%E2%80%93Clarke_correspondence)
* [Newton v. Leibniz calculus controversy](http://en.wikipedia.org/wiki/Newton_v._Leibniz_calculus_controversy)
* [Scientific Revolution](http://en.wikipedia.org/wiki/Scientific_Revolution)
* [Stepped Reckoner](http://en.wikipedia.org/wiki/Stepped_Reckoner) – A mechanical calculator

**Notes**

* 1. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-1) [Franz Exner](http://en.wikipedia.org/w/index.php?title=Franz_Serafin_Exner_(philosopher)&action=edit&redlink=1), "*Über Leibnitz'ens Universal-Wissenschaft*", 1843; ["Universalwissenschaft"](http://www.zeno.org/Meyers-1905/A/Universalwissenschaft) in the [Meyers Großes Konversations-Lexikon](http://en.wikipedia.org/wiki/Meyers_Konversations-Lexikon); Stanley Burris, ["Leibniz's Influence on 19th Century Logic"](http://plato.stanford.edu/entries/leibniz-logic-influence/), [Stanford Encyclopedia of Philosophy](http://en.wikipedia.org/wiki/Stanford_Encyclopedia_of_Philosophy)
  2. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-Philosophy.2C_Vol_1958_2-0) *The History of Philosophy, Vol. IV: Modern Philosophy: From Descartes to Leibniz* by [Frederick C. Copleston](http://en.wikipedia.org/wiki/Frederick_Copleston) (1958)
  3. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-3) "It is in Leibniz that Tarde finds the main conditions for the metaphysics of possession.He sees in Monadology (1714) the beginning of a movement of dissolution of classicalontology (notably the identity of “being” and “simplicity”), which would, in a still implicitand unthinking form, find its most obvious confirmation in today’s science.[The Dynamics of Possession: An Introduction to The Sociology of Gabriel Tarde" by Didier Debaise](http://www.academia.edu/616503/The_Dynamics_of_Possession._An_Introduction_to_The_Sociology_of_Gabriel_Tarde)
  4. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-4) Max Mangold (ed.), ed. (2005) (in German). *Duden-Aussprachewörterbuch (Duden Pronunciation Dictionary)* (7th ed.). Mannheim: Bibliographisches Institut GmbH. [ISBN](http://en.wikipedia.org/wiki/International_Standard_Book_Number) [978-3-411-04066-7](http://en.wikipedia.org/wiki/Special:BookSources/978-3-411-04066-7).
  5. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-5) Eva-Maria Krech et al. (ed.), ed. (2010) (in German). *Deutsches Aussprachewörterbuch (German Pronunciation Dictionary)* (1st ed.). Berlin: Walter de Gruyter GmbH & Co. KG. [ISBN](http://en.wikipedia.org/wiki/International_Standard_Book_Number) [978-3-11-018203-3](http://en.wikipedia.org/wiki/Special:BookSources/978-3-11-018203-3).
  6. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-6) [David Smith](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#SMITH), p.173-181 (1929)
  7. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-7) Roughly 40%, 30%, and 15%, respectively.[www.gwlb.de](http://www.gwlb.de/Leibniz/Leibniz-Nachlass/index.htm). *Leibniz-Nachlass* (i.e. Legacy of Leibniz), *Gottfried Wilhelm Leibniz Bibliothek* (one of the three Official Libraries of the German state [Lower Saxony](http://en.wikipedia.org/wiki/Lower_Saxony)).
  8. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-8) Baird, Forrest E.; Walter Kaufmann (2008). *From Plato to Derrida*. Upper Saddle River, New Jersey: Pearson Prentice Hall. [ISBN](http://en.wikipedia.org/wiki/International_Standard_Book_Number) [0-13-158591-6](http://en.wikipedia.org/wiki/Special:BookSources/0-13-158591-6).
  9. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-9) [Leibnitiana](http://www.gwleibniz.com/friedrich_leibniz/friedrich_leibniz.html)
  10. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-10) [Johann Amos Comenius](http://en.wikipedia.org/wiki/Johann_Amos_Comenius), *Comenius in England*, Oxford University Press, 1932, p. 6
  11. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-11) Mackie (1845), 21
  12. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-12) Mackie (1845), 22
  13. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-13) Mackie (1845), 26
  14. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-14) Jolley, Nicholas (1995). *The Cambridge Companion to Leibniz*. Cambridge University Press.:20
  15. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-15) Mackie (1845), 38
  16. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-16) Mackie (1845), 39
  17. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-17) Mackie (1845), 40
  18. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-18) Aiton 1985: 312
  19. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-19) Mackie (1845), 41-42
  20. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-20) Mackie (1845), 43
  21. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-21) Mackie (1845), 44-45
  22. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-22) Mackie (1845), 58-61
  23. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-23) Mackie (1845), 69-70
  24. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-24) Mackie (1845), 73-74
  25. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-25) On the encounter between Newton and Leibniz and a review of the evidence, see Alfred Rupert Hall, Philosophers at War: The Quarrel Between Newton and Leibniz (Cambridge, 2002), pp. 44–69.
  26. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-26) Mackie (1845), 117-118
  27. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-27) For a recent study of Leibniz's correspondence with Sophia Charlotte, see [MacDonald Ross](http://www.philosophy.leeds.ac.uk/GMR/homepage/sophiec.html) (1998).
  28. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-28) Mackie (1845), 109
  29. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-29) See Wiener IV.6 and Loemker § 40. Also see a curious passage titled "Leibniz's Philosophical Dream," first published by Bodemann in 1895 and translated on p. 253 of Morris, Mary, ed. and trans., 1934. *Philosophical Writings*. Dent & Sons Ltd.
  30. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-30) Gottfried Wilhelm Leibniz (2012). Peter Loptson. ed. *Discourse on Metaphysics and Other Writings*. Broadview Press. pp. 23-24. [ISBN](http://en.wikipedia.org/wiki/International_Standard_Book_Number) [9781554810116](http://en.wikipedia.org/wiki/Special:BookSources/9781554810116). "The answer is unknowable, but it may not be unreasonable to see him, at least in theological terms, as essentially a deist. He is a determinist: there are no miracles (the events so called being merely instances of infrequently occurring natural laws); Christ has no real role in the system; we live forever, and hence we carry on after our deaths, but then everything — every individual substance — carries on forever. Nonetheless, Leibniz is a theist. His system is generated from, and needs, the postulate of a creative god. In fact, though, despite Leibniz's protestations, his God is more the architect and engineer of the vast complex world-system than the embodiment of love of Christian orthodoxy."
  31. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-31) Christopher Ernest Cosans (2009). *Owen's Ape & Darwin's Bulldog: Beyond Darwinism and Creationism*. Indiana University Press. pp. 102-103. [ISBN](http://en.wikipedia.org/wiki/International_Standard_Book_Number) [9780253220516](http://en.wikipedia.org/wiki/Special:BookSources/9780253220516). "In advancing his system of mechanics, Newton claimed that collisions of celestial objects would cause a loss of energy that would require God to intervene from time to time to maintain order in the solar system (Vailati 1997, 37–42). In criticizing this implication, Leibniz remarks: "Sir Isaac Newton and his followers have also a very odd opinion concerning the work of God. According to their doctrine, God Almighty wants to wind up his watch from time to time; otherwise it would cease to move." (Leibniz 1715, 675) Leibniz argues that any scientific theory that relies on God to perform miracles after He had first made the universe indicates that God lacked sufficient foresight or power to establish adequate natural laws in the first place. In defense of Newton's theism, Clarke is unapologetic: "'tis not a diminution but the true glory of his workmanship that nothing is done without his continual government and inspection”' (Leibniz 1715, 676–677). Clarke is believed to have consulted closely with Newton on how to respond to Leibniz. He asserts that Leibniz's deism leads to “the notion of materialism and fate” (1715, 677), because it excludes God from the daily workings of nature."
  32. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-32) Andreas Sofroniou (2007). *Moral Philosophy, from Hippocrates to the 21st Aeon*. Lulu.com. [ISBN](http://en.wikipedia.org/wiki/International_Standard_Book_Number) [9781847534637](http://en.wikipedia.org/wiki/Special:BookSources/9781847534637). "In a commentary on Shaftesbury published in 1720, Gottfried Wilhelm Leibniz, a Rationalist philosopher and mathematician, accepted the Deist conception of God as an intelligent Creator but refused the contention that a god who metes out punishments is evil."
  33. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-33) Shelby D. Hunt (2003). *Controversy in Marketing Theory: For Reason, Realism, Truth, and Objectivity*. M.E. Sharpe. p. 33. [ISBN](http://en.wikipedia.org/wiki/International_Standard_Book_Number) [9780765609311](http://en.wikipedia.org/wiki/Special:BookSources/9780765609311). "Consistent with the liberal views of the Enlightenment, Leibniz was an optimist with respect to human reasoning and scientific progress (Popper 1963, p.69). Although he was a great reader and admirer of Spinoza, Leibniz, being a confirmed deist, rejected emphatically Spinoza's pantheism: God and nature, for Leibniz, were not simply two different "labels" for the same "thing"."
  34. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-34) Ariew & Garber, 69; Loemker, §§36, 38
  35. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-35) Ariew & Garber, 138; Loemker, §47; Wiener, II.4
  36. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-36) Ariew & Garber, 272–84; Loemker, §§14, 20, 21; Wiener, III.8
  37. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-37) Mates (1986), chpts. 7.3, 9
  38. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-38) Loemker 717
  39. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-39) See Jolley (1995: 129–31), Woolhouse and Francks (1998), and Mercer (2001).
  40. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-40) Loemker 311
  41. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-41) For a precis of what Leibniz meant by these and other Principles, see Mercer (2001: 473–84). For a classic discussion of Sufficient Reason and Plenitude, see Lovejoy (1957).
  42. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-42) Rutherford (1998) is a detailed scholarly study of Leibniz's [theodicy](http://en.wikipedia.org/wiki/Theodicy).
  43. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-43) Magill, Frank (ed.). *Masterpieces of World Philosophy.* New York: Harper Collins (1990).
  44. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-44) Magill, Frank (ed.) (1990)
  45. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-45) *The Art of Discovery* 1685, Wiener 51
  46. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-46) Many of his memoranda are translated in Parkinson 1966.
  47. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-47) Loemker, however, who translated some of Leibniz's works into English, said that the symbols of chemistry were real characters, so there is disagreement among Leibniz scholars on this point.
  48. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-48) *Preface to the General Science*, 1677. Revision of Rutherford's translation in Jolley 1995: 234. Also Wiener I.4
  49. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-49) A good introductory discussion of the "characteristic" is Jolley (1995: 226–40). An early, yet still classic, discussion of the "characteristic" and "calculus" is Couturat (1901: chpts. 3,4).
  50. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-50) Struik (1969), 367
  51. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-Douglas_M._Jesseph.2C_1998_51-0) Jesseph, Douglas M. (1998). ["Leibniz on the Foundations of the Calculus: The Question of the Reality of Infinitesimal Magnitudes"](http://muse.jhu.edu/journals/perspectives_on_science/v006/6.1jesseph.html). [*Perspectives on Science*](http://en.wikipedia.org/wiki/Perspectives_on_Science) **6.1&2**: 6–40. <http://muse.jhu.edu/journals/perspectives_on_science/v006/6.1jesseph.html>. Retrieved 31 December 2011.
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  58. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-58) Ariew and Garber 117, Loemker §46, W II.5. On Leibniz and physics, see the chapter by Garber in Jolley (1995) and Wilson (1989).
  59. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-59) See Ariew and Garber 155–86, Loemker §§53–55, W II.6–7a
  60. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-60) On Leibniz and biology, see Loemker (1969a: VIII).
  61. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-61) On Leibniz and psychology, see Loemker (1969a: IX).
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  63. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-63) Davis (2000) discusses Leibniz's prophetic role in the emergence of calculating machines and of formal languages.
  64. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-64) See Couturat (1901): 473–78.
  65. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-65) Couturat (1901), 115
  66. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-66) [The Reality Club: Wake Up Call for Europe Tech](http://www.edge.org/discourse/schirrmacher_eurotech.html)
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  68. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-68) See, for example, Ariew and Garber 19, 94, 111, 193; Riley 1988; Loemker §§2, 7, 20, 29, 44, 59, 62, 65; W I.1, IV.1–3
  69. [**^**](http://en.wikipedia.org/wiki/Gottfried_Wilhelm_Leibniz#cite_ref-69) See (in order of difficulty) Jolley (2005: chpt. 7), Gregory Brown's chapter in Jolley (1995), Hostler (1975), and Riley (1996).
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* [Gottfried Wilhelm Leibniz](http://www.dmoz.org/Society/Philosophy/Philosophers/L/Leibniz,_Gottfried_Wilhelm/) at the [Open Directory Project](http://en.wikipedia.org/wiki/Open_Directory_Project)
* [translations](http://www.earlymoderntexts.com) by [Jonathan Bennett](http://en.wikipedia.org/wiki/Jonathan_Bennett_(philosopher)), of the *New Essays*, the exchanges with Bayle, Arnauld and Clarke, and about 15 shorter works.
* [Leibnitiana](http://www.gwleibniz.com/) – Gregory Brown.
* [Gottfried Wilhelm Leibniz: Texts and Translations](http://philosophyfaculty.ucsd.edu/faculty/rutherford/Leibniz/index.html), compiled by Donald Rutherford, [UCSD](http://en.wikipedia.org/wiki/UCSD)
* [Leibniz-translations.com](http://www.leibniz-translations.com/) Scroll down for many Leibniz links.
* [Leibniz Prize.](http://www.dfg.de/en/news/scientific_prizes/leibniz_preis/index.html)
* [Philosophical Works of Leibniz translated by G.M. Duncan](http://www.archive.org/details/philosophicalwor00leibuoft)
* [Leibnitiana](http://www.gwleibniz.com/), links and resources compiled by Gregory Brown, [University of Houston](http://en.wikipedia.org/wiki/University_of_Houston).
* [Leibnizian Resources](http://www.helsinki.fi/~mroinila/leibniz1.htm), many links organized by Markku Roinila, [University of Helsinki](http://en.wikipedia.org/wiki/University_of_Helsinki).
* [Leibniz Bibliography](http://www.leibniz-bibliographie.de/DB=1.95/LNG=EN/?COOKIE=U8000,K8000,I0,B1999++++++,SY,NVZG,D1.95,E0ed05df2-2e89,A,H,R194.95.154.1,FY) at the Gottfried Wilhelm Leibniz Library.