Charles Sanders Peirce
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Charles Sanders Peirce (pronounced /ˈpɜːrs/) was an American philosopher, logician, mathematician, and scientist, born in Cambridge, Massachusetts. Peirce was educated as a chemist and employed as a scientist for 30 years. It is largely his contributions to logic, mathematics, philosophy, and semiotics (and his founding of pragmatism) that are appreciated today. In 1934, the philosopher Paul Weiss called Peirce "the most original and versatile of American philosophers and America's greatest logician".[2]

An innovator in many fields (including philosophy of science, epistemology, metaphysics, mathematics, statistics, research methodology, and the design of experiments in astronomy, geophysics, and psychology) Peirce considered himself a logician first and foremost. He made major contributions to logic, but logic for him encompassed much of that which is now called epistemology and philosophy of science. He saw logic as the formal branch of semiotics, of which he is a founder. As early as 1886 he saw that logical operations could be carried out by electrical switching circuits, an idea used decades later to produce digital computers.[3]

Contents

1 Life
   1.1 United States Coast Survey
   1.2 Johns Hopkins University
   1.3 Poverty
2 Reception
3 Works
   4 Mathematics
      4.1 Mathematics of logic
      4.2 Continuity
      4.3 Probability and statistics
   5 Philosophy
      5.1 Theory of categories
      5.2 Esthetics and ethics
   6 Philosophy: Logic, or semiotic
      6.1 Logic as philosophical
      6.2 Signs
      6.3 Modes of inference
      6.4 Pragmatism
   7 Philosophy: Metaphysics
   8 Science of review
9 See also
10 Notes
11 External links

Life

Charles Sanders Peirce was the son of Sarah Hunt Mills and Benjamin Peirce, a professor of astronomy and mathematics at Harvard University, perhaps the first serious research mathematician in America. At 12 years of age, Charles read an older brother's copy of Richard Whately's Elements of Logic, then the leading English-language text on the subject. Thus began his lifelong fascination with logic and reasoning. He went on to obtain the BA and MA from Harvard. In 1863 the Lawrence Scientific School awarded him its first B.Sc. in chemistry, summa cum laude; otherwise his academic record was undistinguished. At Harvard, he began lifelong friendships with Francis Ellingwood Abbot, Chauncey Wright, and William James. One of his Harvard instructors, Charles William Eliot, formed an unfavorable opinion of...
Peirce. This opinion proved fateful, because Eliot, while President of Harvard 1869–1909—a period encompassing nearly all of Peirce's working life—repeatedly vetoed Harvard's employing Peirce in any capacity.

Peirce suffered from his late teens onward from a very painful nervous/facial condition then known as "facial neuralgia", which would today be diagnosed as trigeminal neuralgia. The biography by Joseph Brent[43] says that when in the throes of its pain "he was, at first, almost stupefied, and then aloof, cold, depressed, extremely suspicious, impatient at the slightest crossing, and subject to violent outbursts of temper." Its consequences may have led to the social isolation which made his life's later years so tragic.

**United States Coast Survey**

Between 1859 and 1891, Peirce was intermittently employed in various scientific capacities by the United States Coast Survey, where he enjoyed the protection of his highly influential father until the latter's death in 1880. That employment exempted Peirce from having to take part in the Civil War. It would have been very awkward for him to do so, as the Boston Brahmin Peirces sympathized with the Confederacy. At the Survey, he worked mainly in geodesy and gravimetry, refining the use of pendulums to determine small local variations in the strength of Earth's gravity. The Survey sent him to Europe five times, first in 1871, as part of a group sent to observe a solar eclipse. While in Europe, he sought out Augustus De Morgan, William Stanley Jevons, and William Kingdom Clifford, British mathematicians and logicians whose turn of mind resembled his own. From 1869 to 1872, he was employed as an Assistant in Harvard's astronomical observatory, doing important work on determining the brightness of stars and the shape of the Milky Way. (On Peirce the astronomer, see Lenzen's chapter in Moore and Robin, 1964.) In 1876 he was elected a member of the National Academy of Sciences. In 1878, he was the first to define the meter as so many wavelengths of light of a certain frequency, the definition employed until 1983[5].

During the 1880s, Peirce's indifference to bureaucratic detail waxed while the quality and timeliness of his Survey work waned. Peirce took years to write reports that he should have completed in months. Meanwhile, he wrote hundreds of logic, philosophy, and science entries for the *Century Dictionary*. In 1885, an investigation by the Allison Commission exonerated Peirce, but led to the dismissal of Superintendent Julius Hilgard and several other Coast Survey employees for misuse of public funds. In 1891, Peirce resigned from the Coast Survey at Superintendent Thomas Corwin Mendenhall's request. He never again held regular employment.

**Johns Hopkins University**

In 1879, Peirce was appointed Lecturer in logic at the new Johns Hopkins University, which was strong in a number of areas that interested him, such as philosophy (Royce and Dewey did their PhDs at Hopkins), psychology (taught by G. Stanley Hall and studied by Joseph Jastrow, who coauthored a landmark empirical study with Peirce), and mathematics (taught by J. J. Sylvester, who came to admire Peirce's work on mathematics and logic). This nontenured position proved to be the only academic appointment Peirce ever held.

Brent documents something Peirce never suspected, namely that his efforts to obtain academic employment, grants, and scientific respectability were repeatedly frustrated by the covert opposition of a major American scientist of the day, Simon Newcomb. Peirce's efforts may also have been hampered by a difficult personality; Brent conjectures as to various psychological and other difficulties.[44]

Peirce's personal life also handicapped him. His first wife, Harriet Melusina Fay, left him in 1875. He soon took up with a woman, Juliette, whose maiden name and nationality remain uncertain to this day (the best guess is that her name was Juliette Froissy and that she was French), but his divorce from Harriet became final only in 1883, after which he married Juliette. That year, Newcomb pointed out to a Johns Hopkins trustee that Peirce, while a Hopkins employee, had lived and traveled with a woman to whom he was not married. The ensuing scandal led to his dismissal. Just why Peirce's later applications for academic employment at Clark University, University of Wisconsin–Madison, University of Michigan, Cornell University, Stanford University, and the University of Chicago all failed can no longer be determined. Presumably, his having lived with Juliette for years while still legally married to Harriet led him to be deemed morally unfit for academic employment anywhere in the USA. Peirce had no children by either marriage.

**Poverty**

In 1887 Peirce spent part of his inheritance from his parents to buy 2,000 acres (8 km²) of rural land near Milford, Pennsylvania, which land never yielded an economic return. There he had a large house built to his design. The Peirces named the house and land "Arisbe". There they lived for the rest of their lives, Charles writing prolifically, much of it unpublished to this day. Living beyond their means soon led to grave financial and legal difficulties. He spent much of his last two decades unable to afford heat in winter, and subsisting on old bread donated by the local baker. Unable to afford new stationery, he wrote on the verso side of old manuscripts. An outstanding warrant for assault and unpaid debts led to his being a fugitive in New York City for a while. Several
people, including his brother James Mills Peirce and his neighbors, relatives of Gifford Pinchot, settled his debts and paid his property taxes and mortgage.

Peirce did some scientific and engineering consulting and wrote a good deal for meager pay, mainly dictionary and encyclopedia entries, and reviews for The Nation (with whose editor, Wendell Phillips Garrison, he became friendly). He did translations for the Smithsonian Institution, at its director Samuel Langley's instigation. Peirce also did substantial mathematical calculations for Langley's research on powered flight. Hoping to make money, Peirce tried inventing. He began but did not complete a number of books. In 1888, President Grover Cleveland appointed him to the Assay Commission. From 1890 onwards, he had a friend and admirer in Judge Francis C. Russell of Chicago, who introduced Peirce to Paul Carus and Edward Hegeler, the editor and the owner, respectively, of the pioneering American philosophy journal The Monist, which eventually published 14 or so articles by Peirce. He applied to the newly formed Carnegie Institution for a grant to write a systematic book of his life's work. The application was doomed; his nemesis Newcomb served on the Institution's executive committee, and its President had been the President of Johns Hopkins at the time of Peirce's dismissal.

The one who did the most to help Peirce in these desperate times was his old friend William James, dedicating his Will to Believe (1897) to Peirce, and arranging for Peirce to be paid to give two series of lectures at or near Harvard (1898 and 1903).[37] Most important, each year from 1907 until James's death in 1910, James wrote to his friends in the Boston intelligentsia, asking that they contribute financially to help support Peirce; the fund continued even after James's death. Peirce reciprocated by designating James's eldest son as his heir should Juliette predecease him.[8] It has also been believed that this was why Peirce used "Santiago" ("St. James" in Spanish) as a middle name, but he appeared in print as early as 1890 as Charles Santiago Peirce. (See Charles Santiago Sanders Peirce for discussion and references).

Peirce died destitute in Milford, Pennsylvania, twenty years before his widow.

### Reception

Bertrand Russell (1959) wrote[9], "Beyond doubt [...] he was one of the most original minds of the later nineteenth century, and certainly the greatest American thinker ever." (His Principia Mathematica does not mention Peirce; Peirce's work was not widely known till later.[10]) A. N. Whitehead, while reading some of Peirce's unpublished manuscripts soon after arriving at Harvard in 1924, was struck by how Peirce had anticipated his own "process" thinking. (On Peirce and process metaphysics, see the chapter by Lowe in Moore and Robin, 1964.) Karl Popper viewed Peirce as "one of the greatest philosophers of all times".[11] Yet Peirce's achievements were not immediately recognized. His imposing contemporaries William James and Josiah Royce admired him, and Cassius Jackson Keyser at Columbia and C. K. Ogden wrote about Peirce with respect, but to no immediate effect.

The first scholar to give Peirce his considered professional attention was Royce's student Morris Raphael Cohen, the editor of a 1923 anthology of Peirce's writings titled Chance, Love, and Logic and the author of the first bibliography of Peirce's scattered writings. John Dewey had Peirce as an instructor at Johns Hopkins and, from 1916 onwards, Dewey's writings repeatedly mention Peirce with deference. His 1938 Logic: The Theory of Inquiry is Peircean through and through. The publication of the first six volumes of the Collected Papers (1931–35), the most important event to date in Peirce studies and one that Cohen made possible by raising the needed funds, did not prompt an outpouring of secondary studies. The editors of those volumes, Charles Hartshorne and Paul Weiss, did not become Peirce specialists. Early landmarks of the secondary literature include the monographs by Buchler (1939), Feibleman (1946), and C. K. Ogden (1950), the 1941 Ph.D. thesis by Arthur W. Burks (who went on to edit volumes 7 and 8 of the Collected Papers), and the edited volume Wiener and Young (1952). The Charles S. Peirce Society was founded in 1946. Its Transactions, an academic journal specializing in Peirce, pragmatism, and American philosophy, has appeared since 1965.

In 1949, while doing unrelated archival work, the historian of mathematics Carolyn Eisele (1902–2000) chanced on an autograph letter by Peirce. So began her 40 years of research on Peirce the mathematician and scientist, culminating in Eisele (1976, 1979, 1985). Beginning around 1960, the philosopher and historian of ideas Max Fisch (1900–1995) emerged as an authority on Peirce; Fisch (1986) reprints many of the relevant articles, including a wide-ranging survey (Fisch 1986: 422–48) of the impact of Peirce's thought through 1983.

Peirce has gained a significant international following, marked by university research centers devoted to Peirce studies and pragmatism in Brazil[12], Finland[13], Germany[14], France[15], Spain[16], and Italy[17]. His writings have been translated into several languages, including German, French, Finnish, Spanish, and Swedish. Since 1950, there have been French, Italian, Spanish, British, and Brazilian Peirceans of note. For many years, the North American philosophy department most devoted to Peirce was the University of Toronto's, thanks in good part to the leadership of Thomas Goudge and David Savan. In recent years, U.S. Peirce scholars have clustered at Indiana University - Purdue University Indianapolis, home of the Peirce Edition Project (PEP), and the Pennsylvania State University.

Currently, considerable interest is being taken in Peirce's ideas by researchers wholly outside the arena of academic philosophy. The interest comes from industry, business, technology, intelligence organizations, and the military; and it has resulted in the existence of a substantial number of agencies, institutes, businesses, and laboratories in which ongoing research into and development of Peircean concepts are being vigorously undertaken.

Peirce's reputation rests largely on a number of academic papers published in American scientific and scholarly journals such as *Proceedings of the American Academy of Arts and Sciences*, the *Journal of Speculative Philosophy*, *The Monist*, Popular Science Monthly, *The American Journal of Mathematics*, *Memoirs of the National Academy of Sciences*, *The Nation*, and others. The only full-length book (neither extract nor pamphlet) that Peirce authored and saw published in his lifetime was *Photometric Researches* (1878), a 181-page monograph on the applications of spectrographic methods to astronomy. While at Johns Hopkins, he edited *Studies in Logic* (1883), containing chapters by himself and his graduate students. Besides lectures during his years (1879–1884) as Lecturer in Logic at Johns Hopkins, he gave at least nine series of lectures, many now published; see Lectures by Peirce.

Harvard University bought from Peirce's widow soon after his death the papers found in his study, but did not microfilm them until 1964. Only after Richard Robin (1967) catalogued this *Nachlass* did it become clear that Peirce had left approximately 1650 unpublished manuscripts, totaling over 100,000 pages.[20] Most of it remains unpublished, except on microfilm. For more on the vicissitudes of Peirce's papers, see Houser (1989).[21]

### List of major articles and lectures

See Charles Sanders Peirce bibliography for extensive list of his works with links to many of them readable online.

- On a New List of Categories (Presented 1867, his philosophy's seminal work, see #Theory of categories below.)
- Questions Concerning Certain Faculties Claimed for Man (1868)
- Some Consequences of Four Incapacities (1868. Rejects Cartesian foundationalism, see #Presuppositions of logic below. Also argues that the general is real.)
- Grounds of Validity of the Laws of Logic: Further Consequences of Four Incapacities (1869)
- The Harvard lectures on British logicians (1869–70)
- Description of a Notation for the Logic of Relatives (1870)
- Note on the Theory of the Economy of Research (1876)
- Illustrations of the Logic of Science (1877–78) (See #Pragmatism, below.)
  - The Fixation of Belief (1877)
  - How to Make Our Ideas Clear (1878)
  - The Doctrine of Chances (1878)
  - The Probability of Induction (1878)
  - The Order of Nature (1878)
  - Deduction, Induction, and Hypothesis (1878)
- On the Algebra of Logic (1880)
- A Theory of Probable Inference, Note A: On a Limited Universe of Marks. Note B: The Logic of Relatives (1883)
- On Small Differences in Sensation (with Joseph Jastrow, 1884)
- On the Algebra of Logic: A Contribution to the Philosophy of Notation (presented 1884)
- A Guess at the Riddle (1887–88 MS)
- Trichotomic (1888 MS)
- The *Monist* Metaphysical Series (1891–93)
  - The Architecture of Theories (1891)
  - The Doctrine of Necessity Examined (1892)
  - The Law of Mind (1892)
  - Man's Glassy Essence (1892)
  - Evolutionary Love (1893)
- Immortality in the Light of Synechism (1893 MS)
- The Logic of Relatives (1894)
- The lectures on "Reasoning and the Logic of Things" in Cambridge, MA (1898, invited by William James)
- F.R.L. [First Rule of Logic] (1899 MS against barriers to inquiry, see #Presuppositions of logic below)
- Minute Logic (1901–02 MSS)
- Application of C. S. Peirce to the Executive Committee of the Carnegie Institution (1902)
- The Simplest Mathematics (1902 MS)
- The Harvard lectures on pragmatism (1903)
- The Lowell lectures and syllabus on topics of logic (1903)
- Kain Stoicheia [New Elements] (1904 MS)
- What Pragmatism Is (1905)
- Issues of Pragmatism (1905)
- Prolegomena To An Apology For Pragmatism (1906)
- A Neglected Argument for the Reality of God (1908, outlines much of Peirce's philosophy)

The first published anthology of Peirce's articles was the one-volume *Chance, Love and Logic: Philosophical Essays*, edited by Morris Raphael Cohen, 1923, still in print. Other one-volume anthologies were published in 1940, 1957, 1958, 1972, and 1994, most still in print. The main posthumous editions of Peirce's works in their long trek to light, often multi-volume, and some still in print, have included:


1976: *The New Elements of Mathematics* by Charles S. Peirce (NEM), 4 volumes in 5, included many previously unpublished Peirce manuscripts on mathematical subjects, along with Peirce's important published articles.
mathematical articles. Edited by Carolyn Eisele, out of print.

1977: *Semiotic and Significs: The Correspondence between C. S. Peirce and Victoria Lady Welby* (2nd edition 2001), included Peirce’s entire correspondence (1903–1912) with Victoria, Lady Welby. Peirce’s other published correspondence is largely limited to the 14 letters included in volume 8 of the *Collected Papers*, and the 20-odd pre-1890 items included so far in the *Writings*. Edited by Charles S. Hardwick with James Cook, out of print.

1981–now: *Writings of Charles S. Peirce, A Chronological Edition* (W), Volumes 1–6 & 8, of a projected 30. The limited coverage, and defective editing and organization, of the *Collected Papers* led Max Fisch and others in the 1970s to found the Peirce Edition Project (PEP), whose mission is to prepare a more complete critical chronological edition. Only seven volumes have appeared to date, but they cover the period from 1859–1892, when Peirce carried out much of his best-known work. W 8 was published in November 2009; and work continues on W 7, 9, and 11. In print from Indiana U.

1985: *Historical Perspectives on Peirce's Logic of Science: A History of Science, 2 volumes*. Auspitz has said[22], “The extent of Peirce’s immersion in the science of his day is evident in his reviews in the Nation […] and in his papers, grant applications, and publishers’ prospectuses in the history and practice of science”, referring latterly to *Historical Perspectives*. Edited by Carolyn Eisele, out of print.


1992–98: *The Essential Peirce* (EP), 2 volumes, is an important recent sampler of Peirce’s philosophical writings. Edited (1) by Nathan Hauser and Christian Kloesel and (2) by PEP editors, in print from Indiana U.

1997: *Pragmatism as a Principle and Method of Right Thinking* collects Peirce’s 1903 Harvard “Lectures on Pragmatism” in a study edition, including drafts, of Peirce’s lecture manuscripts, which had been previously published in abridged form; the lectures now also appear in EP 2. Edited by Patricia Ann Turisi, in print from SUNY (http://www.sunypress.edu/details.asp?id=55996).

2010: *Philosophy of Mathematics: Selected Writings* collects important writings by Peirce on the subject, many not previously published. Edited by Matthew E. Moore, in print from Indiana U.

(Mathematics)

Peirce’s most important work in pure mathematics was in logical and foundational areas. He also worked on linear algebra, matrices, various geometries, topology and Listing numbers, Bell numbers, graphs, the four-color problem, and the nature of continuity. He worked not only in pure areas but also on applications for economics, engineering, and map projections (the Peirce quincuncial projection of a sphere keeps angles true except at several isolated points and results in less distortion of area than in other projections), and he was especially active in probability and statistics.[23]

Peirce made a number of striking discoveries in foundational mathematics, nearly all of which came to be appreciated only long after he died. He:

- Discovered in 1880[24] how Boolean algebra could be expressed via a single binary operation, either NAND or its dual, NOR, anticipating Henry M. Sheffer by 33 years. (See also De Morgan's Laws).
- In Peirce (1881)[25] set out the now-classic axiomatization of natural number arithmetic, a few years before Dedekind and Peano. In the same paper Peirce gave, years before Dedekind, the first purely cardinal definition of a finite set in the sense now known as "Dedekind-finite", and implied by the same stroke an important formal definition of an infinite set (Dedekind-infinite), as a set that can be put into a one-to-one correspondence with one of its proper subsets.
- In Peirce (1885), set out what can be read as the first (primitive) axiomatic set theory, anticipating Zermelo by about two decades.

Peirce wrote drafts for an introductory textbook, with the working title *The New Elements of Mathematics*, that presented mathematics from an original standpoint. Those drafts and many other of his previously unpublished mathematical manuscripts finally appeared[23] in *The New Elements of Mathematics by Charles S. Peirce* (1976), edited by mathematician Carolyn Eisele.

Peirce agreed with Auguste Comte in regarding mathematics as more basic than philosophy and the special sciences (of nature and mind). Peirce classified mathematics into three subareas: (1) mathematics of logic, (2) discrete series, and (3) pseudo-continuous series (as he called them, including the real numbers) and continuous series. Influenced by his father Benjamin, Peirce argued for the following propositions:

http://en.wikipedia.org/wiki/Charles_Sanders_Peirce
Mathematics is not just the science of quantity but is more broadly the science which draws necessary conclusions.
Mathematics studies purely hypothetical objects.
Mathematics aids logic, not vice versa. (Here, Peirce criticized Dedekind's logicism.)
Logic itself is part of philosophy and is the science about drawing conclusions necessary and otherwise. 

Mathematics of logic

Beginning with his first paper on the "Logic of Relatives" (1870), Peirce extended the theory of relations that Augustus De Morgan had just recently awakened from its Cinderella slumbers. Much of the mathematics of relations now taken for granted was "borrowed" from Peirce, not always with all due credit (Anellis 1995[10]). In 1918 the logician C. I. Lewis wrote, "The contributions of C.S. Peirce to symbolic logic are more numerous and varied than those of any other writer — at least in the nineteenth century."[12] Beginning in 1940, Alfred Tarski and his students rediscovered aspects of Peirce's larger vision of relational logic, developing the perspective of relational algebra.

Relational logic gained applications. In mathematics, it influenced the abstract analysis of E. H. Moore and the lattice theory of Garrett Birkhoff. In computer science, the relational model for databases was developed with Peircean ideas in work of Edgar F. Codd, who was a doctoral student of Arthur W. Burks, a Peirce scholar. In economics, relational logic was used by Frank P. Ramsey, John von Neumann, and Paul Samuelson to study preferences and utility and by Kenneth J. Arrow in Social Choice and Individual Values, following Arrow's association with Tarski at City College of New York.

On Peirce and his contemporaries Ernst Schröder and Gottlob Frege, Hilary Putnam (1982) documented that Frege's work on the logic of quantifiers had little influence on his contemporaries, although it was published four years before the work of Peirce and his student Oscar Howard Mitchell. Mathematicians and logicians learned about the logic of quantifiers through the independent work of Peirce and Mitchell, particularly through Peirce's "On the Algebra of Logic: A Contribution to the Philosophy of Notation" (1885), published in the premier American mathematical journal of the day, and cited by Peano and Ernst Schröder, among others, who ignored Frege. These researchers also adopted and modified Peirce's notations, typographical variants of those now used. Peirce apparently was ignorant of Frege's work, despite their overlapping achievements in logic, philosophy of language, and the foundations of mathematics. On how the young Bertrand Russell, especially his Principles of Mathematics and Principia Mathematica, did not do Peirce justice, see Anellis (1995)[10].

Peirce's other major discoveries in formal logic include:

- Distinguishing (Peirce, 1885) between first-order and second-order quantification.[28]
- Seeing that Boolean calculations could be carried out via electrical switches,[30] anticipating Claude Shannon by more than 50 years.
- Existential graphs, a diagrammatic notation for the predicate calculus. Based on them are John F. Sowa's conceptual graphs and Sun-Joo Shin's diagrammatic reasoning.

Peirce's work on formal logic had admirers besides Ernst Schröder:

- Philosophical algebraist William Kingdon Clifford and logician William Ernest Johnson, both British;
- The Polish school of logic and foundational mathematics, including Alfred Tarski;
- Arthur Prior, whose Formal Logic and chapter in Moore and Robin (1964) praised and studied Peirce's logical work.


A philosophy of logic, grounded in his categories and semiotic, can be extracted from Peirce's writings and, along with Peirce's logical work more generally, is exposted and defended in Hilary Putnam (1982)[34]; the Introduction in Houser et al. (1997)[35]; and Dipert's chapter in Misak (2004)[36].

Continuity

Continuity and synecdoche are important, even crucial, in Peirce's philosophy. He embraced infinitesimals and worked long on the mathematics of continua. He held for many years that the real numbers constitute a pseudo-continuum[30] and that a true continuum[37] of instants:

- exceeds in size any Aleph number (any infinite multitude as he called it) soever infinitely great,
- has, within any lapse of time, room enough for any such multitude, and
- is the real subject matter of that which we now call topology.

In 1908 he gave up on that particular conception of continua.[38]

Probability and statistics

Peirce held that science achieves statistical probabilities, not certainties, and that spontaneity (absolute chance) is real. Most of his statistical writings promote the frequency interpretation of probability (objective ratios of cases), and many of his writings express skepticism about (and criticize the use of) probability when such models are not based on objective randomization.[39] Though Peirce was largely a frequentist, his possible world semantics introduced the "propensity" theory of probability before Karl Popper.[40][41] Peirce
Peirce was one of the founders of statistics. He formulated modern statistics in "Illustrations of the Logic of Science" (1877–8) and "A Theory of Probable Inference" (1883). With a repeated measures design, he introduced blinded, controlled randomized experiments (before Ronald A. Fisher). He invented optimal design for experiments on gravity, in which he "corrected the means". He used logistic regression, correlation, and smoothing. Peirce attended the work on outliers by Benjamin Peirce, his father. He introduced terms "confidence" and "likelihood" (before Jerzy Neyman and Fisher). (See Stephen Stigler's historical books and Ian Hacking 1990:200–201.)

Philosophy

It is not sufficiently recognized that Peirce’s career was that of a scientist, not a philosopher; and that during his lifetime he was known and valued chiefly as a scientist, only secondarily as a

logician, and scarcely at all as a philosopher. Even his work in philosophy and logic will not be understood until this fact becomes a standing premise of Peircean studies. (Max Fisch, in Fisch, Moore, and Robin 1964, 486).

Peirce was a working scientist for 30 years, and arguably was a professional philosopher only during the five years he lectured at Johns Hopkins. He learned philosophy mainly by reading, each day, a few pages of Kant's Critique of Pure Reason, in the original German, while a Harvard undergraduate. His writings bear on a wide array of disciplines, including astronomy, metrology, geodesy, mathematics, logic, philosophy, the history and philosophy of science, statistics, linguistics, economics, and psychology. This work has enjoyed renewed interest and approval, a revival inspired not only by his anticipations of recent scientific developments but also by his demonstration of how philosophy can be applied effectively to human problems.

Peirce's philosophy includes a pervasive three-category system, fallibilism, critical common-sensism (fallibilistic but not radically skeptical), logic as formal semiotic, philosophical pragmatism, which he founded, Scholastic realism, theism, objective idealism, and belief in the reality of continuity and of chance, mechanical necessity, and evolutionary love. In his work, fallibilism and pragmatism may be seen as playing roles somewhat similar to those of skepticism and positivism, respectively, in others' work. However, for Peirce, fallibilism is a basis for belief in the reality of chance and continuity, and pragmatism fortifies belief in the reality of the general.

For Peirce, First Philosophy, which he also called cenoscopgy, is less basic than mathematics and more basic than the special sciences (of nature and mind). It studies positive phenomena in general, phenomena available to any person at any waking moment, and does not settle questions by resorting to special experiences.[42] He divided such philosophy into (1) phenomenology (which he also called phaneroscopy or categories), (2) normative sciences (esthetics, ethics, and logic), and (3) metaphysics; his views on them are discussed in order below.

Theory of categories

Main article: Categories (Peirce)

On May 14, 1867, the 27-year-old Peirce presented a paper entitled "On a New List of Categories (http://www.cspeirce.com/menu/library/bycsp/newlist/nl-frame.htm) " to the American Academy of Arts and Sciences, which published it the following year. The paper outlined a theory of predication, involving three universal categories which Peirce developed in response to reading Aristotle, Kant, and Hegel, categories which Peirce applied throughout philosophy and elsewhere for the rest of his life. Most students of Peirce will readily agree on their prevalence in his philosophical work. Peirce scholars generally regard the "New List" as foundational or breaking the ground for Peirce's "architectonc", his blueprint for a pragmatic philosophy. In the categories one will discern, concentrated, the pattern which one finds formed by the three grades of foundational or breaking the ground for Peirce's "architectonic", his blueprint for a pragmatic philosophy. In the categories one will discern, concentrated, the pattern which one finds formed by the three grades of clearness in "How To Make Our Ideas Clear" (1878 foundational paper for pragmatism), and in numerous other trichotomies in his work.

*On a New List of Categories" is cast as a Kantian deduction; it is short but dense and difficult to summarize. The following table is compiled from that and later works.

<table>
<thead>
<tr>
<th>Name</th>
<th>Typical characterizaton:</th>
<th>As universe of experience:</th>
<th>As quantity:</th>
<th>Technical definition:</th>
<th>Valence, &quot;adicity&quot;:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firstness.</td>
<td>Quality of feeling.</td>
<td>Ideas, chance, possibility.</td>
<td>Vagueness, &quot;some&quot;.</td>
<td>Reference to a ground (a ground is a pure abstraction of a quality).[44]</td>
<td>Essentially monadic (the quale, in the sense of the qualc,[45] which has the quality).</td>
</tr>
<tr>
<td>Secondness.</td>
<td>Reaction, resistance, (dyadic) relation.</td>
<td>Brute facts, actuality.</td>
<td>Singularity, discreteness, &quot;this&quot;.</td>
<td>Reference to a correlate (by its relate).</td>
<td>Essentially dyadic (the relate and the correlate).</td>
</tr>
<tr>
<td>Thirdness.</td>
<td>Representation, mediation.</td>
<td>Habits, laws, necessity.</td>
<td>Generality, continuity, &quot;all&quot;.</td>
<td>Reference to an interpretant*.</td>
<td>Essentially triadic (sign, object, interpretant*).</td>
</tr>
</tbody>
</table>

*Note: An interpretant is an interpretation in the sense of the product of an interpretive process or the content of an interpretation.

Esthetics and ethics
Peirce did not write extensively in esthetics and ethics, but held that, together with logic in the broad sense, those studies comprise the normative sciences. He defined esthetics as the study of good and bad. He held that, as the study of good and bad, esthetics is the study of the ends governing all conduct and comes ahead of other normative studies.[46]

Peirce reserved the spelling "aesthetics" for the study of artistic beauty.

**Philosophy: Logic, or semiotic**

**Logic as philosophical**

Peirce regarded logic *per se* as a division of philosophy, as a normative science after esthetics and ethics, as more basic than metaphysics,[47], and as "the art of devising methods of research"[48]. More generally, as inference, "logic is rooted in the social principle", since inference depends on a standpoint that, in a sense, is unlimited[49], Peirce called (with no sense of depreciation) "mathematics of logic" much of the kind of thing which, in current research and applications, is called simply "logic". He was productive in both (philosophical) logic and logic's mathematics, which were connected deeply in his work and thought. Peirce argued that logic is formal semiotic[50], the formal study of signs in the broadest sense, not only signs that are artificial, linguistic, or symbolic, but also signs that aresemblances or are indexical such as reactions. Peirce held that "all this universe is perfused with signs, if it is not composed exclusively of signs", along with their representational and inferential relations. He argued that, since all thought takes time, all thought is in signs[52] and sign processes ("semiosis") such as the inquiry process. He divided logic into: (1) speculative grammar, or stochiology, on how signs can signify and, in relation to that, what kinds of signs there are, how they combine, and how some embody or incorporate others; (2) logical critic, or logic proper, on the modes of inference; and (3) speculative rhetoric, or methodicute, the philosophical theory of inquiry, including pragmatism.

**Presuppositions of logic**

In his "F.R.L." [First Rule of Logic] (1899), Peirce states that the first, and "in one sense, this sole", rule of reason is that, to learn, one needs to desire to learn and desire it without resting satisfied with that which one is inclined to think.[47] So, the first rule is, *to wonder*. Peirce proceeds to a critical theme in the shaping of theories, not to mention associated practices:

...there follows one corollary which itself deserves to be inscribed upon every wall of the city of philosophy:

Do not block the way of inquiry.

Peirce adds, that method and economy are best in research but no outright sin inhereis in trying any theory in the sense that the investigation via its trial adoption can proceed unimpeded and undiscouraged, and that "the one unpardonable offence" is a philosophical barricade against truth's advance, an offense to which "metaphysicians in all ages have shown themselves the most addicted". Peirce in many writings holds that logic precedes metaphysics (ontological, religious, and physical).

Peirce goes on to list four common barriers to inquiry: (1) Assertion of absolute certainty; (2) maintaining that something is absolutely unknowable; (3) maintaining that something is absolutely inexplicable because absolutely basic or ultimate; (4) holding that perfect exactitude is possible, especially such as to quite preclude unusual and anomalous phenomena. To refuse absolute certainty is the heart of fallibilism, which Peirce unfolds into refusals to set up any of the listed barriers. Peirce elsewhere argues (1897) that logic's presupposition of fallibilism leads at length to the view that chance and continuity are very real (tychism and synechism).[53]

One might have thought that, as a whole, the topic belongs within theory of inquiry ("Methodicute" or "Philosophical or Speculative Rhetoric"), his third department of logic; but the First Rule of Logic pertains to the mind's presuppositions in undertaking reason and logic, presuppositions, for instance, that there are truth and real things independent of what you or I think of them (see below). He describes such ideas as, collectively, hopes which, in particular cases, one is unable seriously to doubt.[54] Peirce argues that it is fruitless to start philosophy from paper doubts, make-believe doubts, so he rejects Cartesian foundationalism; and Peirce argues that one cannot conceive of the absolutely incognizable, so he rejects the conception (usually ascribed to Kant) of the unknowable thing-in-itself.[55] Those rejections grew into that which he called critical common-sensism, which he regarded as a prerequisite for pragmatism.[56] It involves the idea that only genuine doubt can power genuine inquiry. It is a kind of combination of (1) Thomas Reid's common-sense philosophy, which resists purging philosophy for the sake of hyperbolic doubts, with (2) a fallibilism which recognizes that even beliefs which we do not now doubt in our hearts may eventually come into sincere
Logic as formal semiotic

Every mind which passes from doubt to belief must have ideas which follow after one another in time. Every mind which reasons must have ideas which not only follow after others but are caused by them. Every mind which is capable of logical criticism of its inferences, must be aware of this determination of its ideas by previous ideas. (Peirce, "On Time and Thought", W 3:68–9.)

Peirce sought, through his wide-ranging studies through the decades, formal philosophical ways to articulate thought's processes, and also to explain the workings of science. These inextricably entangled questions of a dynamics of inquiry involving nature and nurture led him to develop a theory of signs (semiotic) with very broadened conceptions of signs and inference, and, as its culmination, a theory of inquiry for the task of saying how science works and devising research methods. This would be logic by the medieval definition taught for centuries: art of arts, science of sciences, having the way to the principles of all methods. Influences radiate from points on parallel lines of inquiry in Aristotle's work, in such loci as:

- The basic terminology of psychology, in On the Soul.
- The founding description of sign relations, in On Interpretation;
- The differentiation of the genus of reasoning into three species of inference that are commonly translated into English as abduction, deduction, and induction, in the Prior Analytics, as well as reasoning by analogy (called paradeigma by Aristotle), which Peirce understood in terms of abductive and inductive inference.

Inquiry is a special kind of inference process, a specially conducted manner of thinking. Philosophers of the pragmatic school hold with Peirce that "all thought is in signs," where 'sign' is the word for the broadest variety of conceivable semblances, indices, symptoms, signals, symbols, formulas, texts, and so on up the line. Even mental concepts and ideas are held to be signs, corresponding to the thinking agent's inner states that result both in and from interpretation of signs inner and outer.

The subsumption of inquiry within general and the inclusion of thinking within the class of sign processes let us approach inquiry as a topic from two different perspectives:

- The syllogistic approach treats inquiry as a species of logical process, and is limited to those of its aspects that can be related to the most basic laws of inference,
- The sign-theoretic approach treats inquiry as a genus of semiosis, an activity unfolding within the more general setting of sign relations.

Peirce's formal semiotic is philosophical logic studied in terms of signs and sign processes. He uses examples often from common experience, but defines and discusses such things as assertion and interpretation mainly in terms of philosophical logic, focusing on sign action in general rather than on psychology, linguistics, or social studies (though he pursued those fields too). In a formal vein, Peirce says:

*On the Definition of Logic. Logic is formal semiotic. A sign is something, A, which brings something, B, its interpretant sign, determined or created by it, into the same sort of correspondence (or a lower implied sort) with something, C, its object, as that in which itself stands to C. This definition no more involves any reference to human thought than does the definition of a line as the place within which a particle lies during a lapse of time. It is from this definition that I deduce the principles of logic by mathematical reasoning, and by mathematical reasoning that, I aver, will support criticism of Weierstrassian severity, and that is perfectly evident. The word "formal" in the definition is also defined. (Peirce, "Carnegie Application", NEM 4:54).*

Peirce called his general study of signs semiotic or semeiotic. Both terms are current in both singular and plural forms. Peirce began writing on semiotic in the 1860s, around the time when he devised his system of three categories. He based his semiotic always on the conception of a triadic sign relation. In 1907 he defined semiosis as "action, or influence, which is, or involves, a cooperation of three subjects, such as a sign, its object, and its interpretant, this tri-relative influence not being in any way resolvable into actions between pairs."

**Signs**

Main article: Semiotic elements and classes of signs (Peirce)

**Sign relation**

Anything is a sign — not absolutely as itself, but instead in some relation or other. The sign relation is the key. It defines three roles encompassing (1) the sign, (2) the sign's subject matter, called its object, and (3) the sign's meaning or ramification as formed into a kind of effect called its interpretant (a further sign, for example a translation). It is an irreducible triadic relation, according to Peirce. The roles are distinct even when the things that fill those roles are not. The roles are but three; a sign of an object leads to one or more interpreters, and, as signs, they lead to further interpreters.

Extension × intension = information. Two traditional approaches to sign relation, necessary though insufficient, are the way of extension (a sign's objects, also called breadth, denotation, or application) and the way of intension (the objects' characteristics, qualities, attributes referenced by the sign, also called depth, comprehension, significance, or connotation). Peirce adds a third, the way of information, including change of information, to integrate the other two approaches into a unified whole. For example, because of the
equation above, if a term's total amount of information stays the same, then the more that the term 'intends' or signifies about objects, the fewer are the objects to which the term 'intends' or applies. A proposition's comprehension consists in its implications.[60]

Determination. A sign depends on its object in such a way as to represent its object — the object enables and, in a sense, determines the sign. A physically causal sense of this stands out especially when a sign consists in an indicative reaction. The interpretant depends likewise on both the sign and the object — the object determines the sign to determine the interpretant. But this determination is not a succession of dyadic events, like a row of toppling dominoes; sign determination is triadic. For example, an interpretant does not merely represent something which represented an object; instead an interpretant represents something as a sign representing an object. It is an informational kind of determination, a rendering of something more determinately representative.[63] Peirce used the word "determine" not in a strictly deterministic sense, but in a sense of "specializes," bestimmt,[65] involving variation in measure, like an influence. Peirce came to define sign, object, and interpretant by their (triadic) mode of determination, not by the idea of representation, since that is part of what is being defined.[65] The object determines the sign to determine another sign — the interpretant — to be related to the object as the sign is related to the object, hence the interpretant, fulfilling its function as sign of the object, determines a further interpretant sign. The process is logically structured to perpetuate itself, and is definitive of sign, object, and interpretant in general.[63]

Semiotic elements

Peirce held there are exactly three basic elements in semiosis (sign action):

1. A sign (or representamen)[64] represents, in the broadest possible sense of "represents". It is something interpretable as saying something about something. It is not necessarily symbolic, linguistic, or artificial.

2. An object (or semiotic object) is a subject matter of a sign and an interpretant. It can be anything discussable or thinkable, a thing, event, relationship, quality, law, argument, etc., and can even be fictional, for instance Hamlet.[65] All of those are special or partial objects. The object most accurately is the universe of discourse to which the partial or special object belongs.[66] For instance, a perturbation of Pluto's orbit is a sign about Pluto but ultimately not only about Pluto.

3. An interpretant (or interpretant sign) is the sign's more or less clarified meaning or ramification, a kind of form or idea of the difference which the sign's being true or undeceptive would make. (Peirce's sign theory concerns meaning in the broadest sense, including logical implication, not just the meanings of words as properly clarified by a dictionary.) The interpretant is a sign (a) of the object and (b) of the interpretant's "predecessor" (the interpreted sign) as being a sign of the same object. The interpretant is an interpretation in the sense of a product of an interpretive process or a content in which an interpretive relation culminates, though this product or content may itself be an act, a state of agitation, a conduct, etc. As Peirce sometimes put it (he defined sign at least 76 times[65]), the sign stands for the object to the interpretant.

Some of the understanding needed by the mind depends on familiarity with the object. To know what a given sign denotes, the mind needs some experience of that sign's object, experience outside of, and collateral to, that sign or sign system. In that context Peirce speaks of collateral experience, collateral observation, collateral acquaintance, all in much the same terms.[67]

Classes of signs

Among Peirce's many sign typologies, three stand out, interlocked. The first typology depends on the sign itself, the second on how the sign stands for its denoted object, and the third on how the sign stands for its object to its interpretant. Also, each of the three typologies is a three-way division, a trichotomy, via Peirce's three phenomenological categories: (1) quality of feeling, (2) reaction, resistance, and (3) representation, mediation.

I. Qualisign, sinsign, legisign (also called tone, token, type, and also called potisign, actisign, famisign): This typology classifies every sign by the sign's own phenomenological category—the qualisign is a quality, a possibility, a "First"; the sinsign is a reaction or resistance, a singular object, an actual event or fact, a "Second"; and the legisign is a habit, a rule, a representational relation, a "Third".

II. Icon, index, symbol: This typology, the best known one, classifies every sign by the category of the sign's way of denoting its object—the icon (also called semblance or likeness) by a quality of its own, the index by factual connection to its object, and the symbol by a habit or rule for its interpretant.

III. Rheme, dicisign, argument (also called sumisign, dicisign, suadisign, also seme, pheme, delome, and regarded as very broadened versions of the traditional term, proposition, argument): This typology classifies every sign by the category which the interpretant attributes to the sign's way of denoting its object—the rheme, for example a term, is a sign interpreted to represent its object in respect of quality; the dicisign, for example a proposition, is a sign interpreted to represent its object in respect of fact; and the argument is a sign interpreted to represent its object in respect of habit or law. This is the culminating typology of the three, where the sign is understood as a structural element of inference.

Every sign belongs to one class or another within (I) and within (II) and within (III). Thus each of the three typologies is a three-valued parameter for every sign. The three parameters are not independent of each other; many co-classifications are absent, for reasons pertaining to the lack of either habit-taking or singular reaction in a quality, and the lack of habit-taking in a singular reaction. The result is not 27 but instead ten classes of signs fully specified at this level of analysis.

Modes of inference

Main article: Inquiry
Borrowing a brace of concepts from Aristotle, Peirce examined three basic modes of inference in inquiry, processes currently known as abductive, deductive, and inductive inference. Peirce also called abduction "retroduction", "presumption", and, earlist of all, "hypothesis". He characterized it as guessing and as inference to an explanatory hypothesis. He sometimes expounded the modes of inference by transformations of the categorical syllogism (Barbara: AAI), for example in "Deduction, Induction, and Hypothesis" (1878).[68] He does this by rearranging the rule (Barbara's major premiss), the case (Barbara's minor premiss), and the result (Barbara's conclusion):

<table>
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<tbody>
<tr>
<td>Rule: All the beans from this bag are white.</td>
<td>Case: These beans are [randomly selected] from this bag.</td>
<td>Rule: All the beans from this bag are white.</td>
</tr>
<tr>
<td>Case: These beans are from this bag.</td>
<td>Result: These beans are white.</td>
<td>Case: These beans are from this bag.</td>
</tr>
<tr>
<td>; Result: These beans are white.</td>
<td>^ Rule: All the beans from this bag are white.</td>
<td>^ Case: These beans are from this bag.</td>
</tr>
</tbody>
</table>

Peirce 1883 in "A Theory of Probable Inference" (Studies in Logic) equated hypothetical inference with the induction of characters of objects (as he had done in effect before).[55] Eventually dissatisfied, by 1900 he distinguished them once and for all and also wrote that he now took the syllogistic forms and the doctrine of logical extension and comprehension as being less basic than he had thought. In 1903 he presented the following logical form for abductive inference.[69]

The surprising fact, C, is observed;
But if A were true, C would be a matter of course,
Hence, there is reason to suspect that A is true.

The logical form does not also cover induction, since induction neither depends on surprise nor proposes a new idea for its conclusion. Induction seeks facts to test a hypothesis; abduction seeks a hypothesis to account for facts. "Deduction proves that something must be; Induction shows that something actually is operative; Abduction merely suggests that something may be."[70] Peirce did not remain quite convinced that one logical form covers all abduction.[71] In his methodeutic or theory of inquiry (see below), he portrayed abduction as an economic initiative to further inference and study, and portrayed all three modes as clarified by their coordination in essential roles in inquiry: hypothesis, deductive prediction, inductive testing.

Pragmatism

Main articles: Pragmatism, Pragmatic maxim, and Pragmatic theory of truth#Peirce

Peirce's recipe for pragmatic thinking, which he called pragmatism and, later, pragmaticism, is recapitulated in several versions of the so-called pragmatic maxim. Here is one of his more emphatic reiterations of it:

Consider what effects that might conceivably have practical bearings you conceive the objects of your conception to have. Then, your conception of those effects is the whole of your conception of the object.

William James, among others, regarded two of Peirce's papers, "The Fixation of Belief" (1877) and "How to Make Our Ideas Clear" (1878) as pragmatism's origin. Peirce (CP 5.11–12), like James[72] saw pragmatism as embodying familiar attitudes, in philosophy and elsewhere, elaborated into a new deliberate method of thinking and resolving dilemmas. Peirce differed from James and the early John Dewey, in some of their tangential enthusiasms, in being decidedly more rationalistic and realistic, in several senses of those terms, throughout the preponderance of his own philosophical moods. In 1905 Peirce announced his coinage "pragmaticism" and said that the word "pragmatism" was taking on a vulgar literary sense (today "pragmatism" outside of philosophy often connotes compromise or abandonment of aims or principles). Peirce gave another reason in a surviving draft letter c. 1905, saying that "pragmatism" should be used to single his pragmatism out amid its affiliation with those of "Schiller, James, Dewey, Royce, and the rest of us." In a 1906 manuscript he gave as the reason some of James's and Schiller's ideas of pragmatism. In a 1908 publication he said that he was finally moved to coin "pragmatism" upon journalist, pragmatist, and literary author Giovanni Papini's declaration of pragmatism's indefinability, then Peirce detailed his combined satisfaction and dismay with fellow pragmatists.[73]

Pragmatism begins with the idea that belief is that on which one is prepared to act. Peirce's pragmatism is a method of clarification of conceptions of objects. It equates any conception of an object to a conception of that object's effects to a general extent of the effects' conceivable implications for informed practice. It is a method of sorting out conceptual confusions occasioned, for example, by distinctions that make (sometimes needed) formal yet not practical differences. He formulated both pragmatism and statistical principles as aspects of scientific method in general, in his "Illustrations of the Logic of Science" series of articles. In the second one, "How to Make Our Ideas Clear", Peirce discusses three grades of clearness of conception:

1. Clearness of a conception familiar and readily used, even if unanalyzed and undeveloped.
2. Clearness of a conception in virtue of clearness of its definition's parts, in virtue of which logicians called an idea "distinct", that is, clarified by analysis of just what makes it applicable. Elsewhere, echoing Kant, Peirce calls such a definition "nominal" (CP 5.553).
3. Clearness in virtue of clearness of conceivable practical implications of the object's conceived effects, such as fosters fruitful reasoning, especially on difficult problems. Here he introduces that which he later called the pragmatic maxim.

By way of example of how to clarify conceptions, he addresses conceptions about truth and the real as
questions of the presuppositions of reasoning in general. In clearness's second grade (the "nominal" grade), he
defines truth as a sign's correspondence to its object, and the real as the object of such correspondence, such
that truth and the real are independent of that which you or I or any actual, definite community of inquirers
think. After that needful but confined step, next in clearness's third grade (the pragmatic, practice-oriented
grade) he defines truth as that opinion which would be reached, sooner or later but still inevitably, by research
taken far enough, such that the real does depend on that ideal final opinion—a dependence to which he appeals
in theoretical arguments elsewhere, for instance for the long-run validity of the rule of induction. Peirce
argues that even to argue against the independence and discoverability of truth and the real is to presuppose
that there is, about that very question under argument, a truth with just such independence and discoverability.

Peirce said that a conception's meaning consists in "all general modes of rational conduct" implied by
"acceptance" of the conception—that is, if one were to accept, first of all, the conception as true, then what
could one conceive to be consequent general modes of rational conduct by all who accept the conception as
true?—the whole of such consequent general modes is the whole meaning. His pragmatism does not equate a
conception's meaning, its intellectual purport, with the conceived benefit or cost of the conception itself, like a
meme (or, say, propaganda), outside the perspective of its being true, nor, since a conception is general, is its
meaning equated with any definitive set of actual consequences or upshots corroborating or undermining the
conception or its worth. His pragmatism also bears no resemblance to "vulgar" pragmatism, which
misleadingly connotes a ruthless and Machiavellian search for mercenary or political advantage. Instead the
pragmatic maxim is the heart of his pragmatism as a method of experimental mental reflection arriving at conceptions in terms of conceivable confirmatory and disconfirmatory circumstances—a method hospitable to the formation of explanatory hypotheses, and conducive to the use and improvement of verification.

Peirce's pragmatism, as method and theory of definitions and conceptual clearness, is part of his theory of
inquiry, which he variously called "Methoduteic" and "Philosophical or Speculative Rhetoric". He applied
his pragmatism as a method throughout his work.

Theory of inquiry

See also: Inquiry

As a method conducive to explanatory hypotheses as well as predictions and testing, pragmatism leads beyond
the usual duo of foundational alternatives, namely:

- Deduction from self-evident truths, or rationalism;
- Induction from experiential phenomena, or empiricism.

His approach is distinct from foundationalism, empiricist or otherwise, as well as from coherentism, by three
dimensions:

- Active process of theory generation, with no prior assurance of truth;
- Subsequent application of the contingent theory in order to explicate its logical and practical
  implications;
- Testing and evaluation of the provisional theory's utility for the anticipation of future experience,
  in both senses: prediction and control.

Peirce's elaboration of those three dimensions fleshes out an approach to inquiry far more solid than the flatter
image of inductive generalization simpliciter, which is a mere relabeling of phenomenological patterns.
Peirce's pragmatism was the first time the scientific method was proposed as an epistemology for philosophical
questions.

A theory that succeeds better than its rivals in predicting and controlling our world is said to be nearer the
truth. This is an operational notion of truth used by scientists.

In The Fixation of Belief (1877), Peirce described inquiry in general not as the pursuit of truth per se but as
the struggle to move from irritating, inhibitory doubt born of surprise, disagreement, and the like, and to reach
a secure belief, belief being that on which one is prepared to act. That let Peirce frame scientific inquiry as part
of a broader spectrum and as spurred, like inquiry generally, by actual doubt, not mere verbal or hyperbolic
doubt, which he held to be fruitless. Peirce sketched four methods of settling opinion, ordered from least to
most successful:

1. The method of tenacity cling)ing by policy to initial belief) — which brings comforts and decisiveness
   but leads to trying to ignore contrary information and others' views as if truth were intrinsically private,
   not public.
2. The method of authority — which overcomes disagreements but sometimes brutally.
3. The method of congruity or the a priori or the dilettante or "what is agreeable to reason" — which
   promotes conformity less brutally but depends on taste and fashion in paradigms, fosters barren
   disputation, and, like the first two methods, sustains capricious and accidental beliefs.
4. The method of science — the method wherein inquiry can, by its own account, go wrong (fallibilism)
   and thereby tests itself and criticizes, corrects, and improves itself.

Peirce held that, in practical affairs, slow and stumbling ratiocination is often dangerously inferior to instinct,
tradition, and sentiment, and that the scientific method is best suited to theoretical research, which in turn
should not be trammeled by the other methods and practical ends; reason's "first rule" is that in order to
learn, one must desire to learn and, as a corollary, must not block the way of inquiry. Scientific method excels
the others finally by being deliberately designed to arrive — eventually — at the most secure beliefs, upon
which the most successful practices can be based. Starting from the idea that people seek not truth per se but
instead to subdue irritating, inhibitory doubt, Peirce showed how, in the struggle, some can come to submit to
truth for the sake of belief's integrity, seek as truth the guidance of potential conduct correctly to its given
goal, and wed themselves to the scientific method.
Peirce extracted the pragmatic model or theory of inquiry from its raw materials in classical logic and refined it in parallel with the early development of symbolic logic to address problems about the nature of scientific reasoning.

Abduction, deduction, and induction make incomplete sense in isolation from each other but comprise a cycle understandable as a whole insofar as they collaborate toward the end of inquiry. In the pragmatic way of thinking in terms of conceivable practical implications, every thing has a purpose, and a thing's purpose is the first thing that we should try to note about it. Abduction hypothesizes explanations for deduction to clarify into implications to be tested so that induction can evaluate the hypotheses, in efforts to move from troublesome uncertainties to secure beliefs. No matter how needful or traditional it may be to study the modes of inference in abstraction from one another, inquiry's integrity strongly limits the effective modularity of inquiry's principal components.

The question, 'How exactly does pragmatic thinking of inquiry's end constrain our guesses?', is generally recognized as the problem of 'giving a rule to abduction'. Peirce's overall answer was the pragmatic maxim. In 1903 Peirce called the question of pragmatism "the question of the logic of abduction".[79]

Peirce outlined the scientific method as follows.[80]

1. **Abduction** (or retrodiction). Guessing, inference to explanatory hypotheses for selection of those best worth trying. From abduction, Peirce distinguishes induction as inferring, on the basis of tests, the proportion of truth in the hypothesis. Every inquiry, whether into ideas, brute facts, or norms and laws, arises from surprising observations in one or more of those realms (and for example at any stage of an inquiry already underway). All explanatory content of theories comes from abduction, which guesses a new or outside idea so as to account in a simple, economic way for a surprising or complicated phenomenon. Oftenest even a well-prepared mind guesses wrong. But the modicum of success of our guesses far exceeds that of random luck, and seems born of attunement to nature by instincts developed or inherent, especially insofar as best guesses are optimally plausible and simple in the sense of 'facile and natural', as by Galileo's natural light of reason and as distinct from 'logical simplicity'. Abduction is the most fertile but least secure mode of inference and has a general inductive rationale in that it succeeds often enough and nothing else suffices in its place.[82]

Methodologically, to abduce a hypothesis leads to judging the hypothesis for its testability and for how its trial would economize inquiry itself.[83] The hypothesis, being insecure, needs to have practical implications leading at least to mental tests and, in science, lending themselves to scientific testing. In economic terms: A simple but unlikey guess may be uncostly to test for falsity and so be worth testing. A guess's objective probability gives value to its trial, while subjective likelihood can be misleading. Guesses can be chosen for trial strategically, for which Peirce offered as example the game of Twenty Questions.[84] One can hope to discover only that which time would reveal through a learner's sufficient experience anyway, so the point is to expedite it; the economy of research is what demands the "leap" of abduction and governs its art.[83]

2. **Deduction**. Analysis of hypothesis and deduction of its consequences in order for induction to test the hypothesis. Two stages:

   i. Explication. Logical analysis of the hypothesis in order to render it as distinct as possible,
   ii. Demonstration (or deductive argumentation). Deduction of hypothesis's consequence. Corollary or, if needed, Theorematic.

3. **Induction**. The long-run validity of the rule of induction is deducible from the principle (presuppositional to reasoning in general) that the real is only the object of the final opinion to which sufficient investigation would lead".[74] Induction involving ongoing tests or observations follows a method which, sufficiently persisted in, will diminish its error below any predesignate degree[80] and, if there were something to which such a process would never lead, then that thing would not be real. Three stages:

   i. Classification. Classing objects of experience under general ideas,
   ii. Probation (or direct Inductive Argumentation); Crude (the enumeration of instances) or Gradual (new estimate of proportion of truth in the hypothesis after each test). Gradual Induction is Qualitative or Quantitative; if Quantitative, then dependent on measurements, or on statistics, or on countings,
   iii. Sentential Induction. "...which, by Inductive reasonings, appraises the different Probations singly, then their combinations, then makes self-appraisal of these very appraisals themselves, and passes final judgment on the whole result".[80]

**Philosophy: Metaphysics**

Peirce divided metaphysics into (1) ontology or general metaphysics, (2) religious metaphysics, and (3) physical metaphysics.

**Ontology**. Peirce was a Scholastic Realist, declaring for the reality of generals as early as 1868.[85] Regarding modalities (possibility, necessity, etc.), he came in later years to regard himself as having wavered earlier as to just how positively real the modalities are. In his 1897 "The Logic of Relatives" he wrote:

> I formerly defined the possible as that which in a given state of information (real or eigned) we do not know not to be true. But this definition today seems to me only a twisted phrase which, by means of two negatives, conceals an anacolouthon. We know in advance of experience that certain things are not true, because we see they are impossible.

Peirce retained, as useful for some purposes, the definitions in terms of information states, but insisted that the pragmatist is committed to a strong modal realism by conceiving of objects in terms of predictive general conditional propositions about how they would behave under certain circumstances.[86]
Religious Metaphysics. Peirce believed in God, and characterized such belief as founded in an instinct explicable in musing over the worlds of ideas, brute facts, and evolving norms — and it is a belief in God not as an actual or existent being (in Peirce's sense of those words), but all the same as a real being.[87] In "A Neglected Argument for the Reality of God" (1908),[88] Peirce sketches, for God's reality, an argument to a hypothesis of God as the Necessary Being, a hypothesis which he describes in terms of how it would tend to develop and become compelling in musement and inquiry by a normal person who is led, by the hypothesis, to consider as being purposed the features of the worlds of ideas, brute facts, and evolving norms, such that the thought of such purposefulness will "stand or fall with the hypothesis"; meanwhile, according to Peirce, the hypothesis, in supposing an "infinitely incomprehensible" being, starts off at odds with its own nature as a parportively true conception, and so, no matter how much the hypothesis grows, it both (A) inevitably regards itself as partly true, partly vague, and as continuing to define itself without limit, and (B) inevitably has God appearing likewise vague but growing, though God as the Necessary Being is not vague or growing; but the hypothesis will hold it to be more false to say the opposite, that God is purposeless.

Physical Metaphysics. Peirce held the view, which he called objective idealism, that "matter is effete mind, invertebrate habits becoming physical laws".[88] Peirce asserted the reality of (1) chance (his tychist view), (2) mechanical necessity (anarchist view), and (3) that which he called the law of love (agapasm view). They embody his categories Firstness, Secondness, and Thirdness, respectively. He held that fortiuate variation (which he also called "sporting"), mechanical necessity, and creative love are the three modes of evolution (modes called "tychasm", "ananasm", and "agapasm") of the universe and its parts. He found his conceptions of agapasm embodied in Lamarckian evolution; the overall idea in any case is that of evolution tending toward an end or goal, and it could also be the evolution of a mind or a society; it is the kind of evolution which manifests workings of mind in some general sense. He said that overall he was a synechist, holding with reality of continuity[90], especially of space, time, and law[91].

Science of review

Main article: Classification of the sciences (Peirce)

Peirce outlined two fields,  "Cenoscopy"  and "Science of Review", both of which could be called "philosophy". Both included philosophy about science. In 1903 he arranged them, from more to less theoretically basic, thus:

   1. Mathematics.
   2. Cenoscopy (philosophy as discussed earlier in this article—categorial, normative, metaphysical), as First Philosophy, concerns positive phenomena in general, does not rely on findings from special sciences, and includes the general study of inquiry and scientific method.
   3. Idioscopy, or the Special Sciences (of nature and mind).

2. Science of Review, as Ultimate Philosophy, arranges "...the results of discovery, beginning with digestes, and going on to endeavor to form a philosophy of science". His examples included Humboldt's Cosmos, Comte's Philosophie positive, and Spencer's Synthetic Philosophy[92]

3. Practical Science, or the Arts.

Peirce placed, within Science of Review, the work and theory of classifying the sciences (including mathematics and philosophy). His classifications, on which he worked for many years, draw on argument and wide knowledge, and are of interest both as a map for navigating his philosophy and as an accomplished polynomial's survey of research in his time.

See also

- Continuous predicate
- Entitative graph
- Hypostatic abstraction
- Idea
- Charles Sanders Peirce
- Laws of Form
- List of American philosophers
- Logic of information
- Logical machine
- Logical matrix
- Mathematical psychology
- Normal distribution
- Peirce's law
- Phaneron
- Pragmatics
- Problem of universals
- Quantification
- Truth table

Contemporaries associated with Peirce

- James Mark Baldwin
- Oliver Wendell Holmes, Jr.
- Howland trial
- Christine Ladd-Franklin
- Allman
- Allon Marquand
- George Herbert Mead
- The Metaphysical Club
- Ventura de los Reyes Prósper
- (http://www.cspeirce.com/menu/library/aboutcsp/nuibiola/reyes.htm)
- F.C.S. Schiller

Notes

Charles Sanders Peirce - Wikipedia, the free encyclopedia

Peirce used his idea that in every continuum there is room for whatever collection of any multitude. From now on, there are


Academy of Sciences, Newport, RI, 14–17 Oct 1884 (see EP 1, 1902, http://www.aip.org/history/peirce/putnam.htm)^ bibliography lists works by Frege, tagged with asterisks as important.

CP 3.553–62. See also his "The Simplest Mathematics" (1902 MS), CP 4.227–323.

See "Peirce's Clarifications on Continuity" by Jérôme Havenel, Peirce (1902 MS), "Analysis of the Methods of Mathematical Demonstration", Memoir 4, Draft C, Manuscript

see ch. 1, §7 “Peirce”, pp. 79–106, see


Peirce (1886), Letter, Peirce to A. Marquand, W 5:421–422.


Peirce (1903 MS), CP 6.176: "But I now define a pseudo-continuum as that which modern writers on the theory of functions call a continuum. But this is fully represented by [...] the totality of real values, rational and irrational [...]."


42. See quotes under "Philosophy" (http://www.helsinki.fi/science/commens/terms/philosophy.html) * at CDPT, such as EP 2:372–1, CP 1:183–6, and CP 1:239–41.


44. The ground blackness is the pure abstraction of the quality black which in turn amounts to which embodies blackness (in which phrase the quality is formulated as reference to the ground). The question is not merely noun (the ground) versus adjective (the blackness), but is whether we are considering the blackness abstracted away from application to an object, or instead as so applied (for instance to a stove). Yet note that Peirce's distinction here is not that between a property-general and a property-individual (a trope). See 'On a New List of Categories (http://www.cspeirce.com/menu/library/bcsp/newulist-frame.html) ' (1867), in the section appearing in CP 1:551. Regarding the ground, cf. the Scholastic conception of a relation's foundation, Google limited preview Droe2 1982, p. 61 (http://books.google.com/books?id=dS6n_-c
GCkZqJPA61&dq=2Introducing+a+Semantic%22+foundations+ground+&hl=kg&bhm=OoCoYx+A0Y4Yx+OlS0x0PFA61)

45. A quale in this sense is a such, just as a quality is a suchness. Cf. under "Use of Letters" in 63 of Peirce's "Description of a Notation for the Logic of Relatives", Memoirs of the American Academy, v. 9, pp. 317–78 (1870), separately reprinted (1870), from which see p. 6 via Google books (http://books.google.com/books?id=FiSlWin5ooLaCkZqJPA61) also reprinted in CP 3:63.

Now logical terms are of three grand classes. The first embraces those whose logical form involves only the conception of quality, and which therefore represent a thing simply as "a ..." These discriminate objects in the most rudimentary way, which does not involve any consciousness of discrimination. They regard an object as it is in itself as such (quaes); for example, as horse, tree, or man. These are absolute terms. (Peirce, 1870. But also see "Quale-Consciousness", 1898, in CP 6:222–37.)

46. See "Charles S. Peirce on Ethics and ESTHES: A Bibliography" by Kelly A. Parker, of the Department of Philosophy, Grand Valley State University, Allendale, Michigan, USA in 1999. Eprint (http://agenda.php.gvsu.edu/kap/CS Friends/Bibliography/CSF_numbib.pdf) (145Kb)


...death makes the number of our risks, the number of our inferences, finite, and so makes their mean result uncertain. The very idea of probability and of reasoning rests on the assumption that this number is indefinitely great. ... logicality inexorably requires that our interests shall not be limited. ... Logic is rooted in the social principle.


52. * * To say, therefore, that thought cannot happen in an instant, but requires a time, is but another way of saying that every thought must be interpreted in another, or that all thought is in signs," Peirce, 1868, "Questions Concerning Certain Faculties Claimed for Man", Journal of Speculative Philosophy 2 (1868), pp. 103–114. Reprinted (CP 5:213–63, the quote is from para. 253). Ariste Eprint (http://www.cspeirce.com/menu/library/bcsp/signs/punctuation/pj-frame.html).

53. * For a fuller discussion by Peirce of fallibilism and its powerful ramifications, see "Fallibilism, Continuity, and Evolution", 1897, CP 1:114–75 (Eprint (http://www.textlog.de/4248.html) ), which the Collected Papers' editors placed directly after "F.R.L." (1899, CP 1:135–40).


57. * Peirce (1897), "On the Evolution of the word "semiotic" and its spellings, see Semiotic#Literature.


59. * Peirce (1867), "Upon Logical Comprehension and Extension" (CP 2:391–426), (W 2:70–86, SEP Eprint (http://www.iupui.edu/~peirce/writings/v2/w2/06/v2.06.06.htm))


62. * Peirce, A Letter to Lady Welby (1908), Semiotic and Significs, pp. 80–1: I define a Sign as anything which is so determined by something else, called its Object, and so determines an effect upon a person, which effect I call its Interpretant, that the latter is thereby mediately determined by the former. My insertion of "upon a person" is a sop to Cerberus, because I despair of making my own broader conception understood.


Page 16 of 19
66. Peirce (1909), A Letter to William James, EP 2.492, see under "Object" at CDPT.
67. See pp. 404–9 in "Pragmatism" in EP 2. Ten quotes on collateral observation from Peirce provided by Joseph Ransdell can be viewed here (http://lyris.ttu.edu/read/messages?id=57101) at peirce-ls Lyris archive. Note: Ransdell's quotes from CP 8.178–9 are also in EP 2.493–4, which gives their date as 1909; and his quote from CP 8.183 is also in EP 2.495–6, which gives its date as 1909.
69. See, under "Abduction" at CDPT.

On correction of “A Theory of Probable Inference”, see quotes from “Minute Logic”, CP 2.102, c. 1902, and from the Carnegie Application (L75), 1902, Historical Perspectives on Peirce's Logic of Science v. 2, pp. 1031–1032.

On new logical form for abduction, see quote from Harvard Lectures on Pragmatism, CP 1.588–189.


70. Lectures on Pragmatism", 1903, CP 5.171.
71. A Letter to J. H. Kelker, NEM 3:203–4, 1911, see under "Retroduction" at CDPT.
72. James, William (1910) Pragmatism: A New Name for Some Old Ways of Thinking.
73. See Pragmatism/Pragmatism's name for discussion and references.
76. Peirce (c. 1906), "PAP (Postlegomena for an Apology to Pragmatism)" (MS 293), NEM 4:319–320, see first quote under "Abductions" at CDPT.
77. See CP 1.34 Eprint (http://www.textlog.de/4220.html) in (The Spirit of Scholasticism), where Peirce ascribes the success of modern science less to a novel interest in verification than to the improvement of verification.
78. See Joseph Ransdell (http://www.cspeirce.com/menu/library/bycsp/l75/intro/l75intro.htm) at CDPT.
81. ...c d e f Peirce, C. S., "On the Logic of Drawing Ancient History from Documents", EP 2, see 107–9. Regarding Twenty Twenty Questions, see 109: Thus, twenty skilful hypotheses will ascertain what 200,000 stupid ones might fail to do.
83. See MS L75.329–330, from Draft D of Memoir 27 (http://www.cspeirce.com/menu/library/cpscp/l75/ver/l75v1-08.htm#m27) Peirce's application to the Carnegie Institution:

Consequently, to discover is simply to expedite an event that would occur sooner or later, if we had not troubled ourselves to make the discovery. Consequently, the art of discovery is purely a question of economics. The economics of research is, so far as logic is concerned, the leading doctrine with reference to the art of discovery. Consequently, the conduct of abduction, which chiefly a question of heuristic and is the first question of heuristic, is to be governed by economical considerations.
84. Peirce, C. S., "On the Logic of Drawing Ancient History from Documents", EP 2, see 107-9. Regarding Twenty Questions, see 109: Thus, twenty skilful hypotheses will ascertain what 200,000 stupid ones might fail to do.
86. On Peirce's moderate, then strong modal realism, see:
• Peirce, C. S. (c. 1905), Letter to Signor Calderoni, CP 8.205–13, especially 208.

87. Peirce in his 1906 "Answers to Questions concerning my Belief in God", CP 6.495 Eprint (http://users.xeternet.com/~gnos/CSP/god.htm), reprinted in part as "The Concept of God" in Philosophical Writings of Peirce, J. Buchler, ed., 1940, pp. 375–8. I will also take the liberty of substituting "reality" for "existence." This is perhaps overscrupulosity; but I myself always use exist in its strict philosophical sense of "react with the other like things in the environment." Of course, in that sense, it would be fetishism to say that God "exists." The word "reality," on the contrary, is used in ordinary parlance in its correct philosophical sense. [...]. I define the real as that which holds its characters on such a tenure that it makes not the slightest difference what any man or men may have thought them to be, or ever will have thought them to be, here using thought to include, imagining, opining, and willing (as long as forcible means are not used); but the real thing's characters will remain absolutely untouched.
External links

- Ariste: The Peirce Gateway (http://www.cspeirce.com/), Joseph Ransdell, ed. 95 online works by Peirce as of 2/17/09, with annotations. 100s of online papers on Peirce. The peirce-1 e-forum. Much else.
- Conceptual Structures (http://conceptualstructures.org/) , holding yearly international conferences.
- Digital Encyclopaedia of Charles S. Peirce (http://www.digiparpe.fee.unicamp.br) , João Queiroz & Ricardo Gadwin, eds., Brazil, in English. 84 authors listed, 51 papers online & more listed, as of 1/31/09.
- International Association for Semiotic Studies (http://iass-aiss.org/) , its journal: Semiotica (http://www.degruyter.de/journals/semiotica/) .
- International Research Group on Abductive Inference (http://user.uni-frankfurt.de/~wirth/) , Uwe Wirth and Alexander Roesler, eds. Uses frames. Click on link at bottom of its home page for English.
- Laboratory for Artificial Intelligence Research. Abductive Inference in Reasoning and Perception (http://www.cse.ohio-state.edu/lair/Projects/Abduction/abduction.html) , John R. Josephson, Ohio State U.
- Open Semiotics Resource Center (http://www.semioticon.com/) . Free online journals, lecture courses, more.
- Peirce Edition Project (PEP) (http://www.iupui.edu/~peirce/) , Indiana U.-Purdue U. Indianapolis (IUPUI), Editors of the Writings of Charles S. Peirce (W) and The Essential Peirce (EP) v. 2. Many study aids such as introductions to EP 1–2 and W 1–6, and the Robin Catalog of Peirce’s manuscripts and letters.
  - Most of W 2 (http://www.iupui.edu/~7Epeirce/writings/v2/loc2.htm) readable online.
- Peirce’s Existential Graphs (http://www.dr-dau.net/eg_readings.shtml) , Frithjof Dau, Germany
- Peirce’s Theory of Semiosis (http://www.chass.utoronto.ca/epc/srt/cyber/espout.html) , Joseph Esposito, Free online course.
- Pragmatism Cybrary (http://www.pragmatism.org/) , John R. Shook, ed.
- Semiotics according to Robert Marty (http://robert.marty.perso.cegetel.net/semiotic/anglais.html) , with 76 definitions of the sign by Peirce.
- Signs - International Journal of Semiotics (http://viv.db.dk/signs/) , Martin Thellens, Torkild Thellens, chief eds.

Charles Sanders Peirce bibliography has numerous external links throughout to Peirce materials readable online, including:

- Biographical and overview articles online at Ariste, the Peirce Edition Project, the Stanford Encyclopedia of Philosophy, the Internet Encyclopedia of Philosophy, and elsewhere.
- Dozens of individual works online by Peirce.
- Online collections of Peirce’s writings and of Peirce-related articles, also online bibliographies and Peirce’s definitions in the Baldwin dictionary.

An earlier version (http://www.anav.es/users/Nupedia_Charles_S.html) of this article, by Jaime Nubiola, was...