George Pólya

George Pólya (/ˈpoʊljə/; Hungarian: *Pólya György*, pronounced [ˈpoːjɒ ˈɟørɟ]; December 13, 1887 – September 7, 1985) was a Hungarian mathematician. He was a professor of mathematics from 1914 to 1940 at ETH Zürich and from 1940 to 1953 at Stanford University. He made fundamental contributions to combinatorics, number theory, numerical analysis and probability theory. He is also noted for his work in heuristics and mathematics education.[3] He has been described as one of The Martians.[4]

Contents

Life and works

Pólya was born in Budapest, Austria-Hungary, to Anna Deutsch and Jakab Pólya, Hungarian Jews who had converted to Christianity in 1886.[5] Although his parents were religious and he was baptized into the Catholic Church upon birth, George eventually grew up to be an agnostic.[6] He was a professor of mathematics from 1914 to 1940 at ETH Zürich in Switzerland and from 1940 to 1953 at Stanford University. He remained a Professor Emeritus at Stanford for the rest of his career, working on a range of mathematical topics, including series, number theory, mathematical analysis, geometry, algebra, combinatorics, and probability.[7] He was invited to speak at the ICM at Bologna in 1928,[8] at Oslo in 1936 and at Cambridge, Massachusetts, in 1950.

He died on September 7, 1985, in Palo Alto, California, United States.[9]

George Pólya

George Pólya, circa 1973

Born	György Pólya December 13, 1887 Budapest, Kingdom of Hungary, Austria-Hungary
Died	September 7, 1985 (aged 97) Palo Alto, California, U.S.
Nationality	Hungarian
Citizenship	Hungarian Swiss (1918–1947) American (1947–)[1]
Alma mater	Eötvös Loránd University
Known for	*Pólya–Szegő inequality* How to Solve It *Multivariate Pólya distribution* *Pólya conjecture* *Pólya enumeration theorem* *Landau–Kolmogorov inequality* *Pólya–Vinogradov inequality*

	Pólya inequality *Pólya–Aeppli distribution* *Pólya urn model* *Fueter–Pólya theorem* *Hilbert–Pólya conjecture* *Jordan–Pólya numbers*
Scientific career	
Fields	Mathematics
Institutions	ETH Zürich Stanford University
Doctoral advisor	Lipót Fejér
Doctoral students	Albert Edrei Hans Einstein Fritz Gassmann Albert Pfluger Walter Saxer James J. Stoker Alice Roth
Influences	E.T. Jaynes[2]
Influenced	Imre Lakatos

Heuristics

Early in his career, Pólya wrote with Gábor Szegő two influential problem books, *Problems and Theorems in Analysis* (*I: Series, Integral Calculus, Theory of Functions* and *II: Theory of Functions. Zeros. Polynomials. Determinants. Number Theory. Geometry*). Later in his career, he spent considerable effort to identify systematic methods of problem-solving to further discovery and invention in mathematics for students, teachers, and researchers.[10] He wrote five books on the subject: *How to Solve It*, *Mathematics and Plausible Reasoning* (*Volume I: Induction and Analogy in Mathematics*, and *Volume II: Patterns of Plausible Inference*), and *Mathematical Discovery: On Understanding, Learning, and Teaching Problem Solving* (volumes 1 and 2).

In *How to Solve It*, Pólya provides general heuristics for solving a gamut of problems, including both mathematical and non-mathematical problems. The book includes advice for teaching students of mathematics and a mini-encyclopedia of heuristic terms. It was translated into several languages and has sold over a million copies. The book is still used in mathematical education. Douglas Lenat's Automated Mathematician and Eurisko artificial intelligence programs were inspired by Pólya's work.

In addition to his works directly addressing problem solving, Pólya wrote another short book called *Mathematical Methods in Science*, based on a 1963 work supported by the National Science Foundation edited by Leon Bowden and published by the Mathematical Association of America (MAA) in 1977. As Pólya notes in the preface, Bowden carefully followed a tape recording of a course Pólya gave several times at Stanford in order to put the book together. Pólya notes in the preface "that the following pages will be useful, yet they should not be regarded as a finished expression."

Legacy

There are three prizes named after Pólya, causing occasional confusion of one for another. In 1969 the Society for Industrial and Applied Mathematics (SIAM) established the George Pólya Prize, given alternately in two categories for "a notable application of combinatorial theory" and for "a notable contribution in another area of interest to George Pólya."[11] In 1976 the Mathematical Association of America (MAA) established the George Pólya Award "for articles of expository excellence" published in the *College Mathematics Journal*.[12] In 1987 the London Mathematical Society (LMS) established the Pólya Prize for "outstanding creativity in, imaginative exposition of, or distinguished contribution to, mathematics within the United Kingdom."[13]

Stanford University has a Polya Hall named in his honor.[14]

Selected publications

Books

- *Aufgaben und Lehrsätze aus der Analysis*, 1st edn. 1925.[15] ("Problems and theorems in analysis“). Springer, Berlin 1975 (with Gábor Szegő).

1. *Reihen*. 1975, 4th edn., ISBN 3-540-04874-X.
2. *Funktionentheorie, Nullstellen, Polynome, Determinanten, Zahlentheorie*. 1975, 4th edn., ISBN 3-540-05456-1.

- *Mathematik und plausibles Schliessen*. Birkhäuser, Basel 1988,

1. *Induktion und Analogie in der Mathematik*, 3rd edn., ISBN 3-7643-1986-0 (Wissenschaft und Kultur; 14).
2. *Typen und Strukturen plausibler Folgerung*, 2nd edn., ISBN 3-7643-0715-3 (Wissenschaft und Kultur; 15).

- – English translation: *Mathematics and Plausible Reasoning*, Princeton University Press 1954, 2 volumes (Vol. 1: Induction and Analogy in Mathematics*, Vol. 2: Patterns of Plausible Inference)*
- *Schule des Denkens. Vom Lösen mathematischer Probleme* ("How to solve it“). 4th edn. Francke Verlag, Tübingen 1995, ISBN 3-7720-0608-6 (Sammlung Dalp).
- – English translation: *How to Solve It*, Princeton University Press 2004 (with foreword by John Horton Conway and added exercises)
- *Vom Lösen mathematischer Aufgaben*. 2nd edn. Birkhäuser, Basel 1983, ISBN 3-7643-0298-4 (Wissenschaft und Kultur; 21).
- – English translation: *Mathematical Discovery: On Understanding, Learning and Teaching Problem Solving*, 2 volumes, Wiley 1962 (published in one vol. 1981)
- *Collected Papers*, 4 volumes, MIT Press 1974 (ed. Ralph P. Boas). Vol. 1: Singularities of Analytic Functions, Vol. 2: Location of Zeros, Vol. 3: Analysis, Vol. 4: Probability, Combinatorics
- with R. C. Read: *Combinatorial enumeration of groups, graphs, and chemical compounds*, Springer Verlag 1987 (English translation of *Kombinatorische Anzahlbestimmungen für Gruppen, Graphen und chemische Verbindungen*, Acta Mathematica, vol. 68, 1937, pp. 145–254)
- with Godfrey Harold Hardy: John Edensor Littlewood *Inequalities*, Cambridge University Press 1934
- *Mathematical Methods in Science* (https://archive.org/details/MATHMETODSSCIENCE), MAA, Washington D. C. 1977 (ed. Leon Bowden)
- with Gordon Latta: *Complex Variables*, Wiley 1974
- with Robert E. Tarjan, Donald R. Woods: *Notes on introductory combinatorics*, Birkhäuser 1983
- with Jeremy Kilpatrick: *The Stanford mathematics problem book: with hints and solutions*, New York: Teachers College Press 1974
- with several co-authors: *Applied combinatorical mathematics*, Wiley 1964 (ed. Edwin F. Beckenbach)
- with Gábor Szegő: *Isoperimetric inequalities in mathematical physics* (https://books.google.com/books/about/Isoperimetric_Inequalities_in_Mathematic.html?id=HWc8gFW2XXgC), Princeton, Annals of Mathematical Studies 27, 1951

Articles

- Pólya, G. (1922). "On the mean-value theorem corresponding to a given linear homogeneous differential equation" (https://doi.org/10.1090%2Fs0002-9947-1922-1501228-5). *Trans. Amer. Math. Soc*. **24** (4): 312–324. doi:10.1090/s0002-9947-1922-1501228-5 (http

s://doi.org/10.1090%2Fs0002-9947-1922-1501228-5). MR 1501228 (https://www.ams.org/mathscinet-getitem?mr=1501228).
- Polya, G. (1941). "On Functions Whose Derivatives Do Not Vanish in a Given Interval" (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1078308). *Proc Natl Acad Sci U S A*. **27** (4): 216–218. Bibcode:1941PNAS...27..216P (https://ui.adsabs.harvard.edu/abs/1941PNAS...27..216P). doi:10.1073/pnas.27.4.216 (https://doi.org/10.1073%2Fpnas.27.4.216). PMC 1078308 (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1078308). PMID 16578010 (https://pubmed.ncbi.nlm.nih.gov/16578010).
- Polya, G. (1941). "Sur l'existence de fonctions entières satisfaisant à certaines conditions linéaires". *Trans. Amer. Math. Soc*. **50** (1): 129–139. doi:10.2307/1989913 (https://doi.org/10.2307%2F1989913). JSTOR 1989913 (https://www.jstor.org/stable/1989913). MR 0004304 (https://www.ams.org/mathscinet-getitem?mr=0004304).
- with Ralph P. Boas, Jr.: Boas, R. P.; Polya, G. (1941). "Generalizations of Completely Convex Functions" (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1078330). *Proc Natl Acad Sci U S A*. **27** (6): 323–325. Bibcode:1941PNAS...27..323B (https://ui.adsabs.harvard.edu/abs/1941PNAS...27..323B). doi:10.1073/pnas.27.6.323 (https://doi.org/10.1073%2Fpnas.27.6.323). PMC 1078330 (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1078330). PMID 16588467 (https://pubmed.ncbi.nlm.nih.gov/16588467).
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- with Norbert Wiener: Pólya, George; Wiener, Norbert (1942). "On the oscillation of the derivatives of a periodic function" (https://doi.org/10.1090%2Fs0002-9947-1942-0007169-x). *Trans. Amer. Math. Soc*. **52** (2): 249–256. doi:10.1090/s0002-9947-1942-0007169-x (https://doi.org/10.1090%2Fs0002-9947-1942-0007169-x). MR 0007169 (https://www.ams.org/mathscinet-getitem?mr=0007169).
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See also

- Integer-valued polynomial
- Laguerre–Pólya class
- Landau–Kolmogorov inequality
- Multivariate Pólya distribution
- Pólya's characterization theorem
- Pólya class

- Pólya conjecture
- Polya distribution
- Pólya enumeration theorem
- Pólya–Vinogradov inequality
- Pólya inequality
- Pólya urn model
- Pólya's theorem
- Pólya's proof that there is no "horse of a different color"
- Wallpaper group
- The Martians (scientists)

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11. Society for Industrial and Applied Mathematics George Pólya Prize (http://www.siam.org/prizes/sponsored/polya.php)
12. Mathematical Association of America George Pólya Award (http://www.maa.org/Awards/polya.html)
13. "London Mathematical Society Polya Prize" (https://web.archive.org/web/20100510090317/http://www.lms.ac.uk/activities/prizes_com/index.html). Archived from the original (http://www.lms.ac.uk/activities/prizes_com/index.html) on May 10, 2010. Retrieved October 9, 2009.
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External links

- The George Pólya Award (http://www.maa.org/Awards/polya.html)
- O'Connor, John J.; Robertson, Edmund F., "George Pólya" (https://mathshistory.st-andrews.ac.uk/Biographies/Polya.html), *MacTutor History of Mathematics archive*, University of St Andrews
- George Pólya (https://mathgenealogy.org/id.php?id=13648) at the Mathematics Genealogy Project
- George Pólya, Gábor Szegö, ***Problems and theorems in analysis*** (1998) (https://books.google.com/books?id=-BoU6EhyU84C&dq=Problems+and+theorems+in+analysis&printsec=frontcover&source=bn&hl=el&ei=2LAOS_zNG9TF_gbnzvzjBA&sa=X&oi=book_result&ct=result&resnum=4&ved=0CBgQ6AEwAw#v=onepage&q=&f=false)
- PolyaPower—an introduction to Polya's Heuristics (https://web.archive.org/web/20090728190041/http://geocities.com/polyapower/) at the Wayback Machine (archived July 28, 2009)
- George Pólya on UIUC's WikEd (https://web.archive.org/web/20090214210940/http://wik.ed.uiuc.edu/index.php/P%C3%B3lya%2C_George)
- Memorial Resolution (https://web.archive.org/web/20060916224323/http://histsoc.stanford.edu/pdfmem/PolyaG.pdf)
- George Pólya (http://www.nasonline.org/publications/biographical-memoirs/memoir-pdfs/polya-george.pdf) — *Biographical Memoirs* of the National Academy of Sciences
- "Polya Guessing" (https://vimeo.com/48768091) on Vimeo