

IN MEMORIAM: HARTLEY ROGERS, JR.
1926–2015

Hartley Rogers Jr. was born in Buffalo, New York on July 6, 1926, and died in Waltham Massachusetts on July 17, 2015. He is survived by his wife, Dr. Adrienne E. Rogers; by his three children, Hartley R. Rogers, Campbell D.K. Rogers, and Caroline R. Broderick; and by 10 grandchildren. He lived a well-rounded life. He was a devoted family man with a successful research career, served as research mentor to many, authored a very influential text still widely read after 50 years, and had a lifelong avocation, rowing.

Hartley attended the venerable independent day school Trinity High in New York City. He was an undergraduate at Yale, and received his B. A. in English in 1946. He spent a year on a Henry fellowship at Cambridge and returned to Yale to earn an M.S. in physics in 1950. He received his Ph.D. in Mathematics from Princeton in 1952. He was a Benjamin Peirce Instructor at Harvard 1952–5. He was appointed assistant professor at MIT in 1956 and was appointed full professor in 1964. He retired in 2009 at the age of 83 as an emeritus professor.

Hartley was one of the stellar Post-World War II Ph.D. students of Alonzo Church. Others from about the same cohort include Leon Henkin, John Kemeny, Martin Davis, and Bill Boone. His area of research was computability (recursive function theory). That such a subject should exist at all was suggested by Gödel and then created in the 1930's and 1940's by Church, his students Alan Turing, Steven Kleene, John Barkley Rosser (Independently by Emil Post.) When Hartley graduated from Princeton with a Ph.D. in 1952, computability as a subject was practically unknown to the general mathematical public. Times change. Now it is a widely pursued research area and a principal foundation for theoretical computer science.

My favorite Rogers theorem (1958) uses Kleene's first recursion theorem to prove the "computable isomorphism" of all "good" computable enumerations of computably enumerable sets. His proof is a refinement of the essential part of Myhill's 1952 proof that any two creative sets are "computably isomorphic" by a computable permutation of the integers. Post introduced creative sets in his 1944 paper "Recursively enumerable sets of positive integers and their decision problems", *Bulletin of the American Mathematical Society* 50: 284–316. Rogers' theorem distinguishes these "good" computable enumerations from the "bad" computable enumerations

without repetitions constructed for him by R.M. Friedberg. Hartley's theorem explained for the first time why it does not matter much which modern universal computer language you learn first, there are faithful computable translations between their programs. Hartley was especially proud to have inspired Friedberg. Friedberg attended Hartley's recursive function theory course as a beginning undergraduate, and after graduating in 1956, published in 1957 a solution to Post's problem of 1944 by constructing two computably enumerable sets of different degrees of unsolvability. The priority method he introduced became a fundamental tool in computability theory. (Post's problem was also solved independently by Muchnik in Russia.)

Roger's own account of his career is to be found in "*Recountings: Conversations with MIT Mathematicians*", (Joel Segal, Ed.), pp.105–156, A. K. Peters. He writes there about the effect on logic and on him of the five week NSF Summer Institute in Symbolic Logic at Cornell (1957). This meeting was what created a mathematical logic community. Although after World War II, Alfred Tarski had established a logic group at Berkeley and Alonzo Church had a stream of students at Princeton, there was no community before this meeting. Paul Halmos, then at the University of Chicago, had the motto "Mathematics is a social science", and suggested to Tarski a meeting of all those doing research in mathematical logic. Tarski and Rosser obtained funding from NSF for a "Summer Institute in Symbolic Logic" which was held at Cornell in White Hall for 5 weeks in August of 1957.

That is where I met Hartley and where we both met and spent five weeks with every prominent logician other than Gödel. Gödel did send up a paper from IAS to be read by Kreisel. Many of those of my generation including Hartley attribute the consequent blossoming of mathematical logic as a research field to that meeting. Before Hartley published his opus "*Theory of Recursive Functions and Effective Computability*" in 1967, the only detailed source on computability was Kleene's *Introduction to Metamathematics* (1952), painstakingly formal in every detail. In 1944 Emil Post opened his famous paper with the dictum that the notion of an algorithm for computably enumerating a set is as fundamental as the notion of a whole number, and can be reasoned about informally without cumbersome notation and without mistakes, just as we do in number theory. Hartley's book was the first to take this seriously. Its intuitive informal arguments inspired a great number of researchers to learn and pursue the subject.

In 1965 Hartley established MIT as the preeminent center for computability research for a generation by bringing Rosser's former pupil Gerald Sacks from Cornell to MIT. Hartley himself directed the dissertations of nineteen mathematicians. Among those mentored who themselves mentored the next generation after, are Pat Fischer, Carl Jockusch Jr., David Luckham, Rohit Parikh, and David Park. They extended Hartley's influence to the world.

Hartley was active in university affairs throughout his career. He played many administrative roles at MIT. He was a member of the Committee on Curriculum Content Planning in 1962–4, which modernized the MIT requirements for undergraduate education. He chaired the 1968 *Panel on*

November Events and the MIT Community, revising the judicial processes of the Institute. He served as Chair of the MIT faculty from 1971 to 1973. He served as associate provost from 1974 to 1980. He was chair of the editorial board of the MIT Press in 1974–1981.

Among his many services to the broader logic community, he served as vice president of the Association for Symbolic Logic and as an editor for several journals including the *Journal of Symbolic Logic*, the *Annals of Mathematical Logic*, and the *Journal of Computer and Systems Sciences*. In 1965 he won the Lewis R. Ford Award of the Mathematical Association of America for one of his expository papers.

Hartley became a lifelong competitive rower after an exposure to the sport in 1946–7, while a Henry Fellow at Cambridge University. For most of the rest of his life he was up at dawn to row on the Charles. He competed in more than 20 “Head of the Charles” Regattas, which has now become the world’s preeminent yearly regatta. He had many administrative roles in that community. He finished first in his class twice, and once second in class in 1997. At the age of 62 he rowed in the Henley Royal Regatta of 1988.

Anil Nerode
Cornell University

Carl Jockusch and Rohit Parikh were kind enough to supply some memories which give insight into Hartley’s character as a mentor:

Carl: “I entered MIT as a graduate student in math in 1963, having no idea what area I would specialize in and not having studied any logic as an undergraduate. After taking a lovely undergraduate course in mathematical logic from Herb Enderton, I took graduate courses in model theory and recursive function theory (as it was then called) from Hartley Rogers. I very much appreciated his clear and intuition-laden lectures and even more his homework problems, which were carefully chosen to be challenging but at a reasonable level. I tried to emulate his use of problems in this way when I later taught logic and indeed borrowed a number of his problems.

I also read with great interest the manuscript for his then forthcoming book “*Theory of Recursive Functions and Effective Computability*”. It was beautifully written, and I still find it to be a useful reference book. I liked the area so much that I discussed with Professor Rogers the possibility of my writing a thesis in it under his direction. Initially I proposed to work in recursive analysis, but he discouraged me from doing so, saying that recursive function theory was much more wide open. In those days, it was indeed much easier than now to make progress in the area, and I was indeed pleased and surprised when he told me that I had done enough for a thesis by 1966. He then found a job for me at Northeastern University since I wanted to remain in the Boston area for another year.

Also in 1966 he invited me to accompany him to a small, elite meeting in mathematical logic at Cornell. I was too shy to talk to the famous logicians in attendance there, but I was very happy to meet other graduate students, including Bob Soare, Manny Lerman, and Jim Owings. I later did joint research with all of them, and of course the interaction with Bob Soare was

especially crucial for me. I am sorry to say that I have had little contact with Hartley since I finished my Ph.D., but obviously his influence during my years as a graduate student was decisive for me. He was a wonderful teacher and role model and encouraged me to enter an area which worked out very well for me.”

Rohit: “In the late 50’s I was a math student at Harvard but Harvard had no logicians in the math department. And Quine had moved away from Math Logic. So I thought of working with Burt Dreben who, however, suddenly decided to take leave for a couple of years. So several of us at Harvard went to Rogers (who was already at MIT) and asked him if he could take us on. He agreed and I started going to his seminar in recursive function theory. He was a dynamite teacher who made unabashed use of the Church-Turing thesis and gave intuitive arguments for all the results. After studying with him I felt there was nothing in RFT I could not do and when I went to Stanford, I solved, within a day or two, questions which Kreisel or Myhill posed to me. Hartley always encouraged you to bite into problems, like a dog with a bone! Sometimes I went to Hartley with a new result I had proved and got the feeling that he didn’t think much of it. I was later astonished to find that some of them ended up in his book (with proper credit to me).

Hartley was very informal but sometimes I wondered if he liked me a bit less than other students because I was Indian. But he was supportive and in 1967 Case made me an offer based essentially entirely on Hartley’s recommendation—so it must have been good. Someone at Case wrote, ‘We were so excited to hear about you from Hartley Rogers.’

My last encounter with him was at a meeting in honor of Emil Post at CCNY. Hartley came and later on I could not find my top coat. So Hartley joined the search and we found it, someone had hung their coat on top of mine. At that moment I felt closer to him as a person than I had when I was his student. But probably it was age, we were both older and more mellow. I hope he was proud of the work I had done, but I think he was.

I owe a lot to him.

(Of course also to our friend Kreisel and to Burt Dreben and to Quine. All were great influences in my life. But Kreisel and Dreben were both hams in their own way. Rogers and Quine were the two sober WASPs.)”