

A Centennial Year (2019) Reflection on the Life and Contributions of Mathematician David H. Blackwell (1919–2010)

Johnny L. Houston

Born on April 24, 1919 in Centralia, Illinois, a town of about 12,000, David Harold Blackwell spent ten years attending public schools there (in elementary school he was twice promoted a year beyond his next grade level). In 1935, at the age of sixteen, he entered the University of Illinois in Champaign-Urbana, earning his AB degree in 1938, his AM in 1939, and his PhD in 1941, all in mathematics. At the age of 22 he had earned a PhD in mathematics and was awarded a prestigious Rosenwald post-doctoral fellowship at the Institute for Advanced Study in Princeton, New Jersey. Yes, David H. Blackwell was viewed as an exceptionally talented person at that time, being only the seventh African American to earn a PhD in mathematics. However, no one at the time envisioned that this was only the beginning of his more than fifty professional years where the annals of history would come to recognize him as a world-class mathematician-statistician and a gifted teacher.

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David was raised in a family that expected and supported working hard to improve the quality of life for members of the family. David's parents were Grover Blackwell and Mabel Johnson Blackwell, and David was the oldest of their four children. Grover Blackwell worked for the Illinois Central Railroad looking after the locomotives, while Mabel looked after the family, nurturing David, his two brothers John Wesley (Skeet) and Joe, and their sister Elizabeth. As a young child, David taught himself how to read even before entering school.

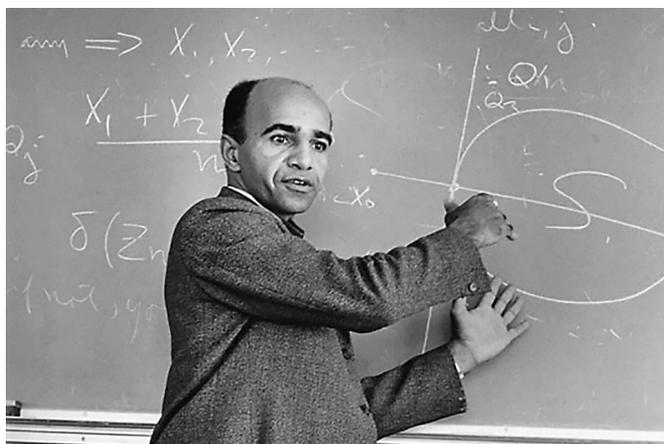
A fair amount of racism existed in Centralia when David was growing up. There were two racially segregated schools, one that only Blacks could attend and one that only Whites could attend, and there was one integrated school. As an African American, David might well have attended the all Black school; however, he lived in a mixed neighborhood and was permitted to attend the integrated school. Blackwell said, "I was fortunate to have attended the integrated school and I had no sense of being discriminated against. My parents protected us from whatever racism existed in general and I didn't encounter enough of it in the schools to notice it [3]."

David was always adept at mathematics, but in high school he did not like algebra or trigonometry. "I could do them and I could see that they were useful, but they were not exciting." However, in high school, geometry was the subject that really caught his attention. His high school geometry teacher, Ms. Caroline Luther, made the subject

HISTORY

beautiful for him. "Geometry connected with activity and motion [1,3]," David said, and he loved the idea of the "helping line," a line that could be drawn to clarify a problem that had previously seemed unsolvable. The advisor to the high school mathematics club, Mr. Huk, encouraged David's interest in math. He would look for problems in the journal of the School Science and Mathematics Association, and bring them in for the club to solve. David's name appeared in the journal three times with others, and once alone when he solved a problem and published the solution with Mr. Huk's assistance.

At the University of Illinois in Champaign-Urbana his interest in mathematics continued to grow. He recalled, "The most interesting thing I remember from calculus was Newton's method for solving equations. That was the only thing in calculus I really liked. The rest of it looked like stuff that was useful for engineers in finding moments of inertia



A young David Blackwell teaching.

and volumes and such." However, during his junior year, he took a course in real analysis, based on Hardy's *Pure Mathematics*. David said, "It was in this class that I realized for the first time that serious mathematics was for me. It became clear that it was not simply a few things that I liked. The whole subject was just beautiful [3]."

His undergraduate years were not easy for David, but he figured out how to make wise use of his time and resources. When he realized that his father was having to borrow money to finance his studies, he took on available jobs, such as "being a waiter," "washing dishes," and working in an entomology lab to help earn money. At the same time he took courses over the summers and was able to graduate with an AB in 1938 after only three years of study. He financed his own education after his freshman year with no further support from his parents. While at the university, he joined the Alpha Phi Alpha fraternity and lived in the Alpha House during five of his six years in residency at the University of Illinois [1]. Initially, David's goal was to become an elementary school teacher. However, after completing

his AB, David continued to study math at the university. He was awarded his AM degree in 1939 and completed his PhD in 1941 with a thesis on Markov chains, supervised by Professor Joseph Doob.

After completing his PhD, he became a Rosenwald Postdoctoral Fellow at the IAS in Princeton. This, however, led Blackwell to encounter blatant racism. The standard practice at IAS was that fellows of the Institute would be honorary faculty members of Princeton University, but in Blackwell's case this practice was challenged. Blackwell was the first African American to be a fellow of the IAS. At that time, Princeton University had never had a Black undergraduate student and certainly not a Black faculty member. Blackwell learned later that Princeton University had in fact rejected Paul Roberson's application to be a student because he was Black. The president of Princeton University wrote to the director of the Institute for Advanced Study saying that the Institute was abusing the hospitality of Princeton University by providing a Black American with such an appointment. In addition, Blackwell was denied the right to attend faculty lectures on the Princeton University campus [5].

Although Blackwell was aware of the problems that his appointment was causing, he was excited to be at the Institute where he met John von Neumann, who was interested in talking to him about his thesis. At IAS, he interacted with other influential mathematicians such as Jimmy Savage, Paul Halmos, Shizuo Kakutani, Sam Wilks, and Dorothy Maharam. Some colleagues at the IAS wanted to extend Blackwell's post-doc beyond the one-year appointment. However, the president of Princeton University organized such opposition that the IAS would not do this.

At the end of his post-doc at the IAS, Blackwell suspected that no predominantly White institution of higher learning would hire him. Blackwell applied to all 105 Black institutions of higher learning in the country to see if any position was available. Out of the 105 applications, Blackwell received three job offers. He chose Southern University in Baton Rouge, LA, over West Virginia State College and Clark



From left to right: J. Ernest Wilkins, Johnny Houston, David Blackwell, and Lee Lorch.

College (now Clark Atlanta University) in Atlanta, GA. "It was the first offer I got," Blackwell said [2].

In spite of his doubt that a predominantly White institution would hire him, Blackwell did apply for a faculty position at the University of California at Berkeley (UCB) and was interviewed by Jerzy Neyman. Neyman strongly supported his appointment, but others in the department had far too strong prejudices to allow Blackwell to be hired. Blackwell and Neyman remained professional colleagues and friends, and they eventually worked together at UCB.

Blackwell was an instructor at Southern University during 1942-43, followed by a year at Clark College. In 1944, Blackwell joined the faculty of Howard University as an instructor. At the time, Howard University "was the ambition of every black scholar." In three years, Blackwell went from instructor to the rank of full professor and became the math department chair at Howard. In spite of heavy teaching and administrative duties and limited research support, Blackwell published a substantial amount of research while he was at Howard.

Blackwell credits a 1945 American Statistical Association lecture by Meyer Abe Girshick with turning his interests toward statistics. Girshick gave a talk on sequential analysis that revolutionized the way Blackwell thought about sampling in two ways. First, where some scientists would limit their sampling before they even began, Blackwell remembers Girshick recommending sampling "until you've seen enough." Blackwell was intrigued by how this approach might be used to more effectively address real world problems. Second, Girshick announced a theorem that Blackwell thought was false. Blackwell worked up a counterexample and sent it to Girshick. It was wrong, but sending it was right. "Instead of dismissing it as the work of a crank," Blackwell said, "he called and invited me to lunch. [2]" Thus began a collaboration that lasted about a dozen years.

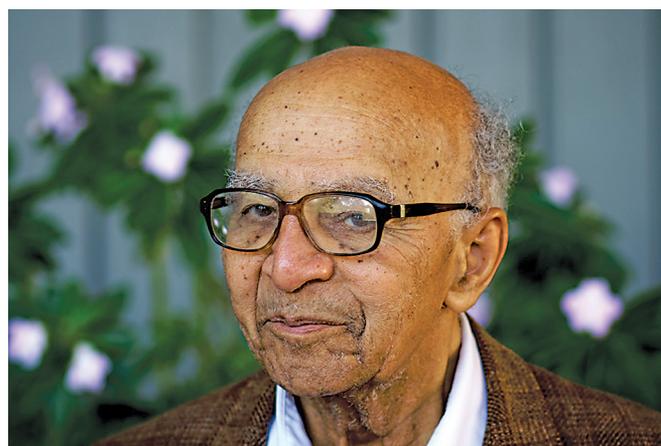
By 1954, Blackwell had spent several summers working on game theory at the RAND Corporation. One of the "games" he worked on was that of two duelists who approached each other each with loaded pistols. If one fires early his chance of hitting the target decreases, but if he waits too long he increases his chance of getting hit. The question is, what is the optimal moment for the duelist to shoot? In a variation of the game the guns are silent and so a player does not know if his opponent has fired unless he is hit. The Cold War did much to promote interest in this type of game, and Blackwell soon became a leading expert [13].

Except for spending the summers of 1948-1950 at the RAND Corporation, and spending 1950-1951 at Stanford University as a visiting professor of statistics, Blackwell was at Howard University for the ten-year period 1944-1954. While at Howard, he distinguished himself as an excellent teacher, an able leader (department chair, 1947-1954), and

a very productive scholar, publishing more than twenty papers during his tenure there.

The same year that Blackwell joined the faculty at Howard University, he married Ann Madison, whom he had met at Clark College. The Blackwells had eight children; four survived his death: son Hugo Blackwell and daughters Ann Blackwell, Vera Gleason, and Sarah Hunt Dahlquist.

In 1954, Blackwell was invited to give an address in probability at the International Congress of Mathematicians (ICM) in Amsterdam. Shortly after his presentation, Blackwell was offered a visiting position in the mathematics and statistics department at the University of California, Berkeley (UCB). Blackwell accepted the offer. The following year, he was elected president of the Institute of Mathematical Statistics and granted a full professorship in the newly formed department of statistics at UCB. Blackwell was the first African American tenured full professor at UCB. After serving as assistant dean of the College of Arts and Sciences, Blackwell served as chair of the statistics department from 1957 to 1961. In the mid-1970s, Blackwell served abroad as director of the University of California Study Center for the United Kingdom and Ireland. With this international appointment came the presidency of the International Association for Statistics in the Physical Sciences. Also, Blackwell was appointed to be the W. W. Rouse Ball Lecturer at Cambridge, and he was made an Honorary Fellow of the Royal Statistical Society.



David Blackwell.

At Berkeley, Blackwell continued the stellar record of research he had started at Howard, working with Elbert Cox, Dudley Woodard, and William W. S. Claytor, the first, second, and third African Americans to earn PhDs in mathematics. He published an additional 50 scholarly papers prior to his retirement in 1989 (a total of 80 altogether), plus he wrote two books: *The Theory of Games and Statistical Decisions*, with M. A. Girshick in 1954, and *Basic Statistics* in 1969.

At UC Berkeley, his reputation as a gifted teacher and great mentor was also well known. Many mathematically talented students went to UC Berkeley with the hope of being in some of his classes or fortunate enough to have him as a thesis advisor. His mathematical genealogy reflects this. Blackwell was highly sought as a visiting scholar and guest lecturer, both nationally and internationally. Students and scholars alike enjoyed attending his presentations. The writer of this document had the privilege of being in his audience on more than one occasion. Each was a scholarly delight. His prolific and impactful productivity as a scholar gained him international fame and high regards; this has not been forgotten.

I. SOME AREAS OF BLACKWELL'S SCHOLARLY LEGACY AND HIS BOOKS

- A. Rao–Blackwell Theorem or Rao-Blackwellization (sometimes referred to as the Rao–Blackwell–Kolmogorov theorem)
- B. Blackwell channel
- C. Blackwell's approachability theory
- D. Arbitrarily varying channel
- E. Infinite Games and Analytic Sets
- F. Game Theory
- G. Games of imperfect information
- H. Dirichlet distribution
- I. Bayesian statistics
- J. Dynamic Programming
- K. Operation Research
- L. Mathematical economics
- M. Recursive economics
- N. Sequential analysis
- O. *Basic Statistics*, 1969
- P. *Theory of Games and Statistical Decisions*, with M.A. Girshick, 1954

II. BLACKWELL MATHEMATICAL DESCENDANTS

The Mathematical Genealogy Project indicates that Prof. Blackwell was the PhD advisor of 65 students and he has 389 descendants; such a genealogy is highly exceptional for any mathematician. His students reflected diversity: by country of origin, by gender, and by ethnicity. Moreover, Prof. Blackwell has inspired, encouraged, and mentored hundreds of people (some vicariously) who have pursued mathematics as a goal or a career.

III. SOME OF BLACKWELL'S PROFESSIONAL POSITIONS

- A. The International Association for Statistics in Physical Sciences, President
- B. The Institute of Mathematical Statistics, President
- C. The Bernoulli Society, President
- D. International Statistical Institute, Vice President
- E. American Statistical Association, Vice President
- F. American Mathematical Society, Vice President

IV. BLACKWELL, SOME HONORS, RECOGNITIONS, AND FIRSTS

- A. The International Congress of Mathematicians, 1954, Invited Speaker (first African American mathematician invited to give an ICM major address)
- B. The National Academy of Sciences, 1965 (Elected) (first and only African American mathematician elected to this Academy)
- C. The American Academy of Arts and Sciences, 1968 (Elected)
- D. Institute for Advanced Study, Princeton, NJ, 1941 (first African American)
- E. Awarded the John von Neumann Prize, 1979 (Operation Research Society)
- F. The R. A. Fisher Award, 1986 (by the Presidents of Statistical Societies)
- G. Appointed Director of UC Study Center, United Kingdom/Ireland (mid 70s)
- H. Appointed W. W. Rouse Ball Lecturer; Cambridge, England
- I. Appointed Fellow of the Royal Statistical Society
- J. The Annual NAM-MAA Blackwell Lecture named in his honor, 1994
- K. The Biennial David Blackwell-Richard Tapia Conference/Prize, began 2000
- L. Selected by the American Mathematical Society to be featured in a film: *Guessing at Random*
- M. A Medley of Tributes (30 + pages) to David Blackwell, (After His Death) by the *Notices of AMS* (928, Volume 58), George G. Roussas, Coord. Editor
- N. Awarded the National Medal of Science in Mathematics, 2014 (posthumously)
- O. The David Blackwell Building (UC Berkeley Campus), Opened Aug. 2018
- P. Awarded Twelve Honorary Doctor of Science Degrees, by:

1. Harvard	2. Yale	3. University of Illinois
4. Howard University		5. Carnegie-Mellon
6. University of Southern California		
7. Michigan State		8. Syracuse
9. Southern Illinois		10. University of Warwick
11. Nat'l Univ. of Lesotho		12. Amherst College

V. SOME PERSPECTIVES FOR KNOWING BLACKWELL BETTER

A. Blackwell said that the work that gave him the most satisfaction was “Infinite games and analytic sets,” which he published in the *Proceedings of the National Academy of Sciences* in 1967. He had found a game theory proof of the Kuratowski Reduction Theorem, connecting the areas of game theory and topology. He said: “This gave me real joy, connecting these two fields that had not been previously connected [3].”

B. Blackwell, who became a diehard Bayesian, said “Jimmy Savage convinced me that the Bayes approach is absolutely the right way to do statistical inference.” Savage had been at the Institute for Advanced Study with him, and they worked together again at RAND. Blackwell said, “I think I was looking for Bayes all along,” and Savage was the one who brought him to it [1].

C. Blackwell’s extensive teaching career has yielded many exciting moments, but one of the ones that stands out is a time when he was working on a problem involving choosing experiments, and he and several of his peers couldn’t seem to find the solution. He mentioned it to a graduate student, and the student was tempted to try the problem. Blackwell said he was initially inclined to discourage the student, who was not among the top students in the program, but he was insistent. The student found the solution, and Blackwell chuckled about it often, so pleased that one of his students solved the problem that it outweighs not solving it himself. This student’s focus was a kind that Blackwell could appreciate.

D. When students asked his advice about the profession, he told them what he would tell them about any other profession: keep trying different things and try to find something you like.

E. In 1957, Blackwell became the chair of the Berkeley’s department of statistics, but the administrative role was less fulfilling. For about a year after stepping down, he said, “my first thought was, ‘I am no longer chairman,’ and it made my day.”

F. “As a scholar, he went from one area to another, and he would write a fundamental paper in each,” Thomas Ferguson, an emeritus professor of statistics at UCLA said. “He would come into a field that had been well studied and find something really new, that was remarkable. That was his forte.”

G. “He had this great talent for making things appear simple,” Peter Bickel, a statistics professor at Berkeley, once said. “He liked elegance and simplicity. That is the ultimate best thing in mathematics, if you have an insight that something seemingly complicated is really simple, but simple after the fact.”

H. In an interview Blackwell was asked the question: “Of the areas in which you have worked, which do you think are the most significant?” He replied, “I’ve worked in so many

areas; I’m sort of a dilettante. Basically, I’m not interested in doing research and I never have been ... I’m interested in understanding, which is quite a different thing. And often to understand something, you have to work it out for yourself because no one else has done it [5].”

VI. LA FIN

The annals of history have recorded that David Harold Blackwell understood much and he shared much.

Blackwell is recognized in the mathematical and statistical communities as being a world-class mathematician-statistician. He is one of the more influential and productive mathematicians-statisticians of recent eras, as well as a very gifted teacher. Many persons consider him the most well-known and famous African American mathematician-statistician, worldwide.

His life and his contributions (before his transition on July 8, 2010) left much for us to reflect during his centennial year, 2019.

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HISTORY



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The graphic features a stylized city skyline in shades of blue and grey. Three orange delivery vans with white trailers are shown driving on a grey road. Each van has a driver and a trailer with the AMS logo. The word 'FREE' is written in large, orange, brush-stroke font at the top, with 'SHIPPING' in blue, bold, sans-serif font below it. The text 'FOR AMS MEMBERS!' is also in blue, bold, sans-serif font. The background includes a sun, clouds, and birds.