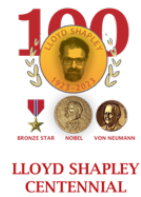


The Master of Games: Lloyd S. Shapley

Xingwei Hu *



Professor Lloyd S. Shapley was my thesis advisor from 1997 to 2000 when he retired and I graduated from UCLA. During my undergraduate studies at the Renmin University of China, I concentrated on applied mathematics and economics, where I learned his name as a towering figure in these fields. So, one primary reason I chose UCLA was that Lloyd was there. Besides, I worked as his teaching assistant in his undergraduate class of Math 167 for about six quarters from 1997 to 2000. In this course, there were almost no references or applications. It looked like pure math or discrete math but with no integrals or derivatives.

He delivered his own class notes at the beginning of each class, when he taught undergraduate Math 167. The class enrollment ranged from 30 to 40 juniors, seniors, or even graduate students. Also, I took his graduate seminar class, in which half of the students were professors, and I enrolled in his individual studies and research classes.

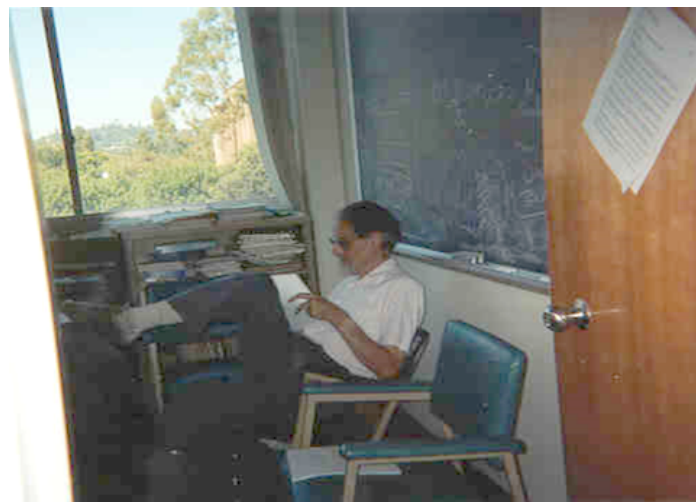


Figure 1. Lloyd Shapley in his office in the UCLA math department.

After my first eight months at UCLA and passing the qualification exams, I finally knocked on his office door in the math department for the first time. It was

one bright afternoon in May. I asked him if he would guide my thesis research. He accepted.

He took two manuscripts from his desk drawer. He said they were cutting-edge works and let me study them. One manuscript was about organization theory formulated by his simple games and the other was on the multi-person utility function. Two other graduate students were also studying these manuscripts. He asked us to work independently and not to exchange ideas. **At that time, economics graduate students and professors knew Lloyd's famous drawer: each manuscript from the drawer was worth a good publication.**

So, in the next few months, Lloyd and I applied his Shapley-Shubik power index to the organization theory and derived a mixed cooperative and noncooperative equilibrium, called counterbalance equilibrium. It has many similarities with the theory of homogenous Markov chains. **Twenty years later, I have been applying the equilibrium to analyzing globalization and trade wars and sorting big data objects.**



Figure 2. On my Ph.D. Graduation in June 2000 (photo by Professor C.Y. Cheng)

All of Lloyd's doctoral students were so lucky because we built our dissertations upon the foundations he laid many years ago. "You are lucky, you are very lucky," said Professor Shmuel Zamir, when he knew I was Lloyd's student. However, I was not able to fully understand many of Lloyd's ideas because my English was "far from perfect" (in his own words), though he also praised me as "brilliant in his

own way.” For example, he suggested I apply trembling hands to the control functions in the organization. I still could not figure out how.

I was also developing an alternative derivation for the Shapley value and the power index, cited in our co-authored publication (2003). He had spent many hours advising me on the derivations but refused to be a co-author. Later, I found that some results in the derivations were already stated, without proof, in his informal publications in the 1960s (Figure 3).

Later publications by other authors may be just special cases of Lloyd’s general results, that did not appear in academic journals. Non-journal publications generally limit access to general researchers. Unfortunately, the majority of his research was not in journals.

Corollary 2 If all players have equal probabilities of voting for the bill and vote independently, i.e. $P_T = p^{|T|}(1 - p)^{n-|T|}$ for some $p \in [0, 1]$, then $\tilde{\phi}_i = \phi_i$.

The corollary was stated, without proof, in Mann and Shapley (1964, p. 153). In particular if $p = 0.5$, we have the main result of Felsenthal and Machover (1996).

Figure 3. Hu (2006, Intl Journal of Game Theory 34, Page 238)

Lloyd cared for students. Besides his intellectual impact on academics, his generosity greatly benefited all his doctoral students. For example, Lloyd gifted a new Mac computer to Shuntian Yao, his first doctoral student, upon Yao’s graduation in 1987.

Before I entered UCLA, there was a mentally stressed graduate student in the math department called Johann. He had previously worked with two other faculty members but failed to make any progress. So, likely, no other professors would supervise Johann on his dissertation. But Lloyd was an exception. Also, Johann lost any financial support from the department since he had been there for over six years. He had tried teaching classes in community colleges, such as Pasadena City College, but all resulted in dismissal because of his mental problem. When Lloyd knew this, he offered Johann \$1,500 monthly from his personal savings until his graduation in 2004.

In the fall of 1999, another graduate student named Ms. Huang enrolled in Lloyd’s advanced game-theory class, hoping to get a recommendation letter for seeking a Ph.D. program in statistics. Due to some adverse conditions, Ms. Huang

didn't do well in her 24-hour take-home final exam. After carefully hearing the explanations, Lloyd kindly assigned a grade of A to avoid any harmful effects on her Ph.D. application. The admissions committee even asked her if the teacher was Professor Shapley. Now Ms. Huang is a professor in Maryland, thanks to Lloyd's kindness. If you ask, I believed, he will give.



Figure 4. On Lloyd's 78th birthday (from left: M. Burgin, Lloyd, M. Baucells, R. Lejano)

Lloyd practiced extreme perfectionism in his life. We often fixed one or two paragraphs for a whole hour when working on our joint papers.

It is weird that he even did not publish his Ph.D. dissertation! It earned him the degree, and *Transactions of the American Mathematical Society* accepted it, subject to a few modifications (Figure 5). But he did not go ahead and publish it.

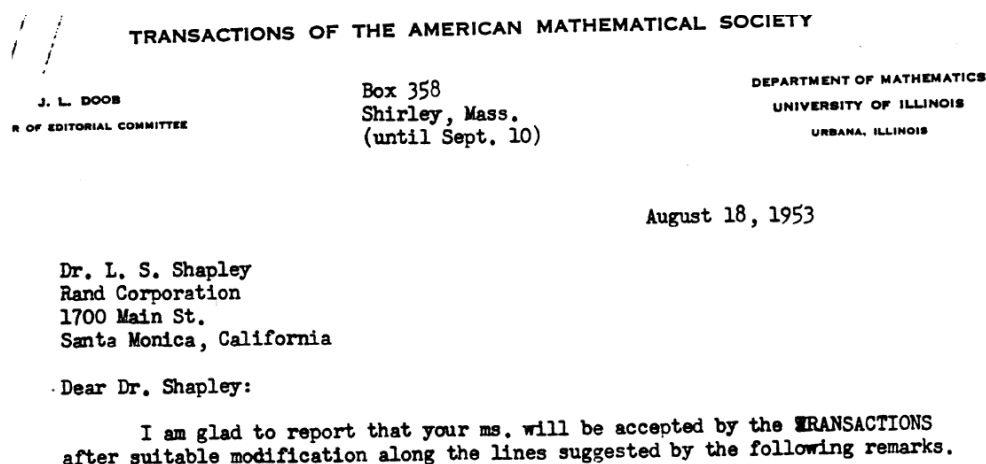


Figure 5. *Transactions* accepted Lloyd's dissertation but he did not proceed with publication.

For the same reason, he left many ideas and manuscripts unpublished; others were overly delayed (Figure 6). Also, some of his original ideas and solution concepts were not written out in any manuscripts. They could be in letters, emails, or oral communications.

A BOOLEAN MODEL OF
ORGANIZATIONAL AUTHORITY, BASED ON
THE THEORY OF SIMPLE GAMES

Lloyd S. Shapley¹
University of California at Los Angeles
June, 1994

Figure 6. Lloyd's presentation in 1969 to the 2nd World Congress of Econometrica Society was only published years later.

Two years ago for a game theory mini-course, Professor Pradeep Dubey cited Lloyd's Math 167 lecture note for an important solution concept, which appeared nowhere in formal publication outlets. I hoped these unpublished manuscripts and solutions would come out to benefit the academic world. And in the last years before his retirement, Lloyd considered annotating and collecting his publications into a work like Robert Aumann's "Collected Papers." Unfortunately, this idea went unrealized.

I hope others will prize as I do this account of how John von Neumann found Lloyd as his inheritor of game theory.

In his book *"Von Neumann, Morgenstern, and the Creation of Game Theory,"* Robert Leonard describes how during a talk at the Rand Corporation, von Neumann was happily presenting his results. "No! No! That can be done much more simply!" Lloyd interjected from the back of the room.

The room suddenly stood still and quiet; everyone could have heard a pin drop. "Come up, young man. Show me," said von Neumann. So Lloyd went up, took the chalk, and wrote down another derivation while von Neumann interrupted and said, "Not so fast, young man. I can't follow." The story's original source came from Hans Speier, who was in the room. As we all know, von Neumann was a child prodigy who could divide two eight-digit numbers in his head at age six.

*Xingwei Hu entered University of California Los Angeles in 1996 after studying in Renmin University of China. He earned his PhD advised by Lloyd Shapley from UCLA in 2000 (see Figure 3). He is currently Computational Economics Lead at the International Monetary Fund. Email xhu@imf.org.

Editor's Note: Other personal recollections are on the Stories page of the Lloyd Shapley Centennial site <https://harlowshapley.org/lloyd-stories>.

Lloyd Shapley Centennial 1923-2023

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