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A Biographical Memoir by

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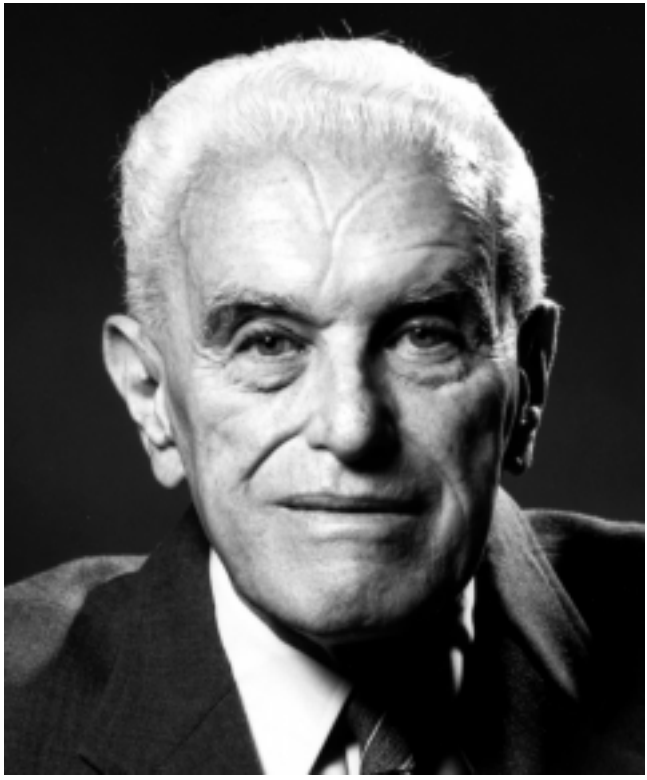

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John C. Hansawzi

JOHN C. HARSANYI

May 29, 1920–August 9, 2000

BY KENNETH J. ARROW

JOHN CHARLES HARSANYI was born on May 29, 1920, in Budapest, Hungary, an only child. His father owned a pharmacy from which he derived a comfortable income. Both parents were Jewish but had converted to Catholicism. His parents were, according to his account, well educated and cultured. He was tutored at home for the first few grades. After elementary school he went to the famous Lutheran Gymnasium in Budapest, graduates of which included John von Neumann, Eugene Wigner (the physicist), and Nicholas Kaldor.

After two years of studying leather chemistry at Grenoble, France, he returned to Hungary with the imminence of World War II to study pharmacy so that he could continue his father's business. He then started (though with little real interest) a doctoral program in botany, mainly to avoid conscription into the army; however, the Germans entered Hungary in March 1944, and in May he was conscripted into forced labor. Fortunately, his work was done in or near Budapest. He was required to wear a white armband, identifying Christians of Jewish origin. His unit was under some form of protection from the Vatican, but when the Russians

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came close to Budapest, the Nazis decided to deport the Jewish forced laborers to Austria. Harsanyi managed to escape from the railway station and hide in the monastery of a Jesuit friend. He was finally freed when the Soviet troops arrived in January 1945.

Harsanyi then enrolled in the University of Budapest. At first he studied mathematics but then shifted to the study of philosophy, psychology, and sociology. Although clearly anti-Marxist, he was allowed to be a university assistant and do some teaching, at which time he met his future wife, Anne. The repression gradually increased, and they decided in 1950 to escape across the border to Austria with Anne's parents. Their guide took three days to take them across because he took a circuitous route to avoid capture (the guide was in fact captured on his next journey and sent to prison).

In Austria they waited seven months for a permit to go to Australia (the Hungarian quota for immigration to the United States was filled for years ahead). The two were married almost immediately on arrival in Australia. He then entered the University of Sydney for an M.A. degree, which was awarded in 1953. Although he intended to continue in sociology, he found the interests of the sociologists there remote from his and enrolled in economics. He then became a lecturer at the University of Queensland, with primary responsibility for external studies (correspondence courses).

He started publishing with great rapidity. By 1955 he had published four papers on economic theory, two of them classics in welfare economics. The others (1953, 1954) were highly competent studies of the economics of research and of the meaning of optimality theorems when tastes are varying over time (a subject then in the literature). The two papers on the foundations of welfare judgments (1953, 1955) were startlingly original. They stemmed from two then cur-

rent developments in economic analysis, the expected-utility hypothesis for behavior under risk, revived and supplied with an axiomatic foundation by John von Neumann and Oskar Morgenstern (1947, Appendix) and Abram Bergson's formulation of the social welfare function (1938).

Bergson sought to ground welfare economics in individual welfare judgments by assuming that ethical evaluations of alternative resource allocations should be represented by a function of individual utilities for them. Let $U_i(x)$ be individual i's utility for alternative x. Then, postulated Bergson, there is a social welfare function of individual utilities, $W(u_1,\ldots,u_n)$, increasing in each argument, where n is the number of individuals in the society, which represents society's ethical choices in the sense that alternative x is socially preferred to alternative y if and only if $W(U_1(x),\ldots,U_n(x)) > W(U_1(y),\ldots,U_n(y))$. Though this representation seems to involve cardinal utilities, Bergson held that it could be interpreted to be valid even for ordinal utilities with no interpersonal comparison.

Harsanyi's contribution was to observe that choices could be made over probability distributions as well as over sure outcomes. Then, he argued, both individuals and society should be assumed rational in their choices under uncertainty in the sense of obeying the von Neumann-Morgenstern axioms. It followed, by a clever argument, that the range of possible welfare functions is very limited. Specifically, if U_i is interpreted to be individual i's von Neumann-Morgenstern utility function, then W must be a positive linear combination of individual utilities,

$$W(u_1,\ldots,u_n) = +\Sigma+a_i\ u_i, \text{ with } a_i > 0, \text{ all i.}$$

The individual utility functions, U_i, are defined up to individual positive-linear transformations; they are cardinal

but not interpersonally comparable. However, argued Harsanyi, variations in the scaling of any individual's utility function can be offset by a corresponding variation in the coefficient, a_i.

It will be seen that Harsanyi's approach leads to a justification of classical utilitarianism from a remarkably new point of view. (The same basic idea, expressed much more informally, had already appeared as almost a side remark in Vickrey (1945, p. 329), but, as I can testify on my own account, it was easy to overlook.).

At this point, evidently, Harsanyi's interests turned more definitely to game theory, in the first instance, to cooperative game theory. The first fruits were his comparison of alternative approaches to the theory of bargaining (1956), comparing the developments of Frederik Zeuthen, John R. Hicks, and John F. Nash, Jr. As long ago as 1930 the Danish economist Zeuthen had written a study of monopoly and what he called "economic warfare" (i.e., oligopolistic competition). He included an analysis of bargaining, which, as Harsanyi showed, was essentially the same as that developed by Nash (1950). (In my view, Zeuthen's contributions to economic theory have never received the recognition they deserve.)

Harsanyi went much farther in seeking to found the theory of cooperative games in general. The publication of this work was bound up with the next stage in his career. At that time, the Rockefeller Foundation offered fellowships to Australians for study in the United States (the Rockefeller Foundation had a major program for bringing senior foreign scholars on visits to the United States even before World War II, and that program had many major consequences). Harsanyi was accepted, with the aim of coming to Stanford University to study for the Ph. D. and work with me.

Harsanyi had written me, and with his publications, some of which I had already known, there was no question of my

willingness to work with him. I more or less assumed that he was probably someone with a strong mathematical background who needed to develop his knowledge of economic theory. On his arrival I found out quickly enough that his knowledge of economics (or at least of economic theory) was such that there was little we could teach him. It was also clear that he had already worked out the ideas for founding cooperative game theory on bargaining analysis, which were to form his dissertation. I finally asked him why he was bothering to take a Ph.D., since neither the Stanford department nor I could provide much added value. He was candid; the Ph.D. was a necessary step in his academic career.

Because I was on leave for the two years Harsanyi was in residence, I was, strictly speaking, not his official thesis supervisor, but we did have many discussions on his work, from which I learned more than he did. In this thesis and the publication (1959) derived from it, the possible outcomes from games involving a coalition and its complement provide the disagreement points for other games, leading ultimately to the allocation by the coalition of the whole. A distinctive feature is that each coalition is considered as playing a zero-sum game with its complement, the payoff being the difference in the values of the two coalitions. While cooperative game theory has still to find a universally accepted solution concept, the Harsanyi analysis is still one of the major tools.

Harsanyi's fellowship was for only one year. He continued as a visitor for one semester at the Cowles Foundation for Research in Economics at Yale University and as visiting assistant professor at Stanford. He returned to Australia in 1958, as required by his visa, and after a short continuation in Queensland, became a senior fellow at the Australian National University until 1961. At this point he was free to

return to the United States, where he took a position as a full professor of economics at Wayne State University in Detroit. In 1964 he was offered a professorship at the School of Business (now the Haas School of Business) at the University of California, Berkeley, where he remained for the rest of his life. His breadth of interests was shown in several papers interpreting bargaining theory in such areas of application as ethics, the measurement of social power, and social status, but these have not had much impact.

At this point Harsanyi began his studies on games with incomplete information, where one player has some information that the other has not (of course, each player may have some private information). An early version (1962) was followed by a fully worked-out analysis (1968). This analysis provided a Magna Carta for an entirely new approach to problems of industrial organization while operating at a very high level of abstraction in which the formal difficulties of mutual knowledge and lack of knowledge were resolved.

The deep problem is that of what might be called interactive knowledge. Suppose there are just two players in the game. Player 1 knows something, say, his or her own payoff function. Player 2 does not know Player 1's information but does know several alternative possibilities (with their probabilities). Player 2 may argue that if Player 1 had payoff function π_1,, Player 1 would take action a_1, but if Player 1 had payoff function π_2, Player 1 would take action a_2. If these are different, then Player 2 can infer what Player 1's payoff function is. Player 1, knowing that his or her actions could reveal his or her type, may prevent this revelation by taking the same action for either payoff function. (This concealment may or may not be profitable to Player 1, depending on the actual game.)

The question is how to formulate the question so as to arrive at a clear application of standard Nash equilibrium

theory. Harsanyi proposed a way of thinking about the matter that got to its heart. Assume each player can be one of a finite number of types; the types of the different players have a known joint distribution. Each player knows his or her own type and therefore has a conditional distribution of the types of the other players. A strategy for an individual is a choice of action for each of his or her possible types. So stated, the game of incomplete information is now a game in the ordinary sense with a larger strategy space for each player. Each player can now make inferences by Bayesian updating conditional on the actions chosen by others.

This approach gave a very general formalism, into which all specific cases could be fitted. Thus, if sellers have more knowledge about the quality of their output than the buyers, we have a game of incomplete information analyzable along Harsanyi lines. Similar examples occur if borrowers know more about the prospects of their firms than the lenders do, and even more complex situations can easily be described. The result was a profound effect, particularly in the field of industrial organization but also with strong application to labor negotiations (with the possibility of strikes) and to finance (e.g., bank runs). Research driven by considerations of abstract theory found rapid application to practical problems probably undreamed of by its creator.

This work was probably Harsanyi's most influential contribution, certainly with regard to applied economics. From the viewpoint of game theory there was one further paper of great importance, a new interpretation of mixed strategies (1973). The concept of mixed strategies was troublesome to many interested in applications of game theory. They did not perceive individuals deliberately randomizing, and somehow these scholars felt that a definite decision had to be made. Suppose, argued Harsanyi, that we think

of the payoff to any one player as being randomly perturbed, though the other players do not observe the perturbation. This is a game of incomplete information. Each individual then has a strategy, which may be regarded as pure, for each possible perturbation. However, because the other players do not observe the perturbation, the strategy of any one player will be a random variable from the viewpoints of other players. Harsanyi showed that as the magnitude of the perturbations tended to zero, the resulting distributions converged to the mixed strategies of ordinary game theory. This understanding is a great clarification of the concept and shows that mixed strategies need not be regarded as the result of deliberate randomization.

There are three more themes that run through much of Harsanyi's work. Two were applications of his work to philosophical considerations: the founding of ethics on utilitarian principles and the implications of the Bayesian approach for epistemology. Though his writings on these subjects were fairly extensive, philosophers were not very responsive. A third, mostly in collaboration with Reinhard Selten, tried to find a general method for selecting among multiple equilibrium points in games, a subject that others have also worked on under the heading of "refinements."

His work was well received from its beginning. The culminating honor was the award of the Nobel Prize in economic science in 1994 jointly to Harsanyi, John F. Nash, Jr., and Reinhard Selten, the first (and thus far only) recognition of game theory by that august body.

Let me conclude by quoting (with slight alteration) two paragraphs from an introduction I wrote to Harsanyi's oral history.

Just a few weeks before his death in August 2000, the newly formed Game Theory Society had held its first International Congress in Bilbao, Spain, and all regretted his absence. In his, the generation that first established game theory as a viable discipline, there were five universally agreed-on outstanding leaders, and unfortunately John alone was absent. But his actual death came as a shock.

John Harsanyi was devoted to matters of the intellect. His physical appearance and demeanor, tall, grave, courteous, cautious in his speech, yet not to be dissuaded from a point or a position he felt strongly about, all fitted a man to whom the intellect and the life of science and rigorous inquiry were the most important things in life. On the subjects he found important, he thought deeply and spoke and wrote only after long reflection.

THE BIOGRAPHICAL STATEMENTS in this memoir are derived from an oral history taken by the Regional Oral History Office, University of California, Berkeley, and from his vita supplied by the Haas School of Business, University of California, Berkeley.

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