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How a Political Scientist Knows What Our Enemies Will Do (Often Before They Do)

From the time of quills and cannons to our era of cyber-attacks and drone warfare, mathematics has been crucial to national security. Equations ensure missiles land on the right target, combat materials hold up on the battlefield, and secrets stay locked in code. But when it comes to the human side of conflict—decisions people make about when, how, and why to use these tools—professionals saw little place for the precise language of mathematics. Until recently.

Political scientists have now added rigorous mathematical techniques to their social-science toolbox, creating methods to explain—and even predict—the actions of adversaries, thus making society safer as well as smarter. Such techniques allowed the U.S. government to predict the fall of President Ferdinand Marcos of the Philippines in 1986, helping hatch a strategy to ease him out of office and avoid political chaos in that nation. And at Los Angeles International Airport a computer system predicts the tactical calculations of criminals and terrorists, making sure that patrols and checkpoints are placed in ways that adversaries can't exploit.

The advances in solving the puzzle of human behavior represent a dramatic turnaround for the field of political science, notes Bruce Bueno de Mesquita, a professor of politics at New York University. "In the mid-1960s, I took a statistics course," he recalls, "and my undergraduate advisor was appalled. He told me that I was wasting my time." It took researchers many years of patient work, putting piece after piece of the puzzle of human behavior together, to arrive at today's new knowledge. The result has been dramatic progress in the nation's ability to protect its interests at home and abroad.

Social scientists have not abandoned the proven tools that Bueno de Mesquita and generations of other scholars acquired as they mastered their discipline. Rather, adding the rigor of mathematical analysis has allowed them to solve more of the puzzle. Mathematical models of human behavior let social scientists assemble a picture of the previously unnoticed forces that drive behavior—forces common to all situations, operating below the emotions, drama, and history that make each conflict unique.

Consider all the possible moves available in a game of chess—more than the number of atoms in the universe, which is why each match a person plays feels unlike any other. Yet expert players know the principles that make for effective moves. Looking at a position, they can often predict what each side must do, based on their knowledge of the underlying principles of the game. In the same way, social scientists can see underlying causes beneath surface differences in human interactions and can represent these fundamental drivers in mathematical formulas. For the method to work, however, researchers need both detailed and accurate data about the conflict they seek to understand as well as a functional model that can make predictions about possible future events.

Often, that information is gathered using the longstanding tools of political science: systematic surveys to reveal individuals' beliefs, extensive interviewing of stakeholders (or experts on the stakeholders) to illuminate their strategic interests, analysis of data to discover the economic underpinnings of conflicts, and extensive archival research to grasp the historical background of a conflict. These social-scientific methods supply the data that ground abstract mathematical modeling in reality.

The key to the new method is to sift through a rich trove of fact and find the few that reveal the essential underlying forces at work. With that knowledge, social scientists build a model—a set of equations that describes the workings of those forces. They first test their mathematical model against known facts: Using older data, does it correctly "predict" the events that actually happened in the past? When it can pass that test, they give it current information to try to predict what is likely to occur in the future. It's similar to weather forecasting or predicting how fish stocks will hold up over a span of years.

For a long time, no scientist thought this kind of mathematical modeling could accurately apply to the human mind or to society. Modeling had its uses, but scholars believed those were confined to the natural world. It took a Hungarian polymath, John von Neumann, to make the connection between high-level math and human actions, and thus let social scientists begin to delineate patterns in seemingly varied human behavior.

Von Neumann was not a social scientist. He had degrees in mathematics and chemistry and an extensive background in physics (Albert Einstein was one of his teachers). His achievements stretched from the basics of the modern computer, through the design of atomic bombs and intercontinental missiles, to nuclear deterrence strategies during the Cold War.[1]

He also happened to be intrigued by the mathematics of parlor games. One of his lectures at Princeton's Institute for Advanced Study in 1937 was on the math of rock-paper-scissors.[2] To von Neumann, these games were even more challenging than problems like how to compress plutonium in the atomic bomb. Atoms obeyed the physical laws described in mathematics. Human beings, in contrast, react to a strategy that is being used against them, changing their own behavior in response. In other words, when you're modeling a game in which you are also

[1] Leonard, R. J. 1995. From Parlor Games to Social Science: Von Neumann, Morgenstern, and the Creation of Game Theory, 1928–1994. *Journal of Economic Literature* 33(2):730–761. http://www.sscnet.ucla.edu/polisci/faculty/chwe/austen/leonard1995.pdf.

[2] Ibid.

a player, you must understand not only your opponent's likely next move, but also his likely response to your answering move, and his guesses about what you'll do after that move.

Von Neumann's work modeling games seemed an arcane sidelight to his other scientific work until he began collaborating with the economist Oskar Morgenstern, who was seeking a more mathematical approach to his social science. The pair went on to publish a book, *Theory of Games and Economic Behavior*, in which they described, for the first time, a formal mathematical logic of games. In the next few decades, their "theory of games" revolutionized economic thinking. From there, these mathematical models slowly spread into other social sciences.

Another mathematician at Princeton, John Forbes Nash—a colorful man who was the subject of a best-selling biography and a hit movie, *A Beautiful Mind*—provided another key piece of the puzzle. He extended the power of von Neumann and Morgenstern's analysis by proving mathematically that for any contest, there is a "best outcome" strategy for every player, such that switching to another one will not improve his or her results. Nash's work gave social scientists a way to use the games model in non-game situations. These are conflicts like the multi-party fighting in Iraq and Syria, in which each "player" has some goals that are in conflict with those of other players, and other goals that align.

Building on Nash's work, the economist Thomas Schelling created a workable model of deterrence that helped American policy makers prevent Armageddon and, eventually, prevail in the country's long struggle against the Soviet Union. (For this and later work on conflict, Schelling and the mathematician Robert J. Aumann shared the Nobel Prize in Economics in 2005.)

The applications of these models were not just for wartime and conflicts. The political scientist William H. Riker built on von Neumann and Morgenstern's principles to solve a different, related problem: how politicians—and nations— form and keep up alliances. It was a new way to do political science, one that deeply impressed Bueno de Mesquita when he arrived at Riker's political science department at the University of Rochester in 1973. Riker's theory of politics "was not about opinion, but logic," Bueno de Mesquita recalls.

After his first encounter with these ideas in the 1970s, Bueno de Mesquita devoted the next four decades to exploring the puzzle of human behavior in more detail. He focused on developing and refining a model for any form of encounter in which one or both sides can resort to force to make the other comply. That, of course, includes war and terrorism. But it also includes the normal competition of politicians for power and even corporate litigation and mergers. From the point of view of his model, Bueno de Mesquita says, "war and political competition are the same problem." And that problem can be cracked with hard information and rigorous mathematical tools.

To make predictions using this model, Bueno de Mesquita conducts research and interviews experts in order to find four key pieces of information: (1) the different positions taken by the people in a conflict, (2) how invested each participant or group is in that position, (3) how much each side values standing its ground versus achieving consensus, and (4) how influential each participant is within his or her own group. This is where the crucial contributions of other social-science methods come in, providing the most accurate possible data.

"If you know those four things," he says, "you can predict what people are likely to do in the conflict. You can work out what people's interests are, what they'll do next, and how they anticipate what you'll do next."

Using this model, Bueno de Mesquita was able to help the U.S. government devise its successful strategy to deal with Ferdinand Marcos.[3] In 1998 the model predicted which parts of the Good Friday Agreement in Northern Ireland would be implemented, which parts would be violated, and that the violations would not be sufficient to scuttle the agreement.[4] In the mid-2000s the model predicted Iran would not develop a nuclear weapon in the immediate future.[5] The predictions Bueno de Mesquita and his colleagues devised thus created new knowledge, improving the ability of policy makers to achieve national goals, and powering the day-to-day fight against crime and terrorism.

One challenge security forces must confront every day, for example, is avoiding routines that adversaries can learn from and exploit. Hence the system deployed at the Los Angeles International Airport, which simulates the strategies of would-be attackers and counters them by keeping the movements of presumed targets from becoming predictable.[6]

Of course, not everyone is comfortable with the idea that a computer, solving equations with a few key pieces of data, can predict people's behavior. Many of us like to imagine that human behavior is more complicated than that, and that our choices, like our morals, cannot be mathematically deduced.

"For me, social science is about understanding how the world works," Bueno de Mesquita replies. "If you are motivated to make the world a better place, that's great. But you are not likely to succeed if you don't understand why it operates the way it does."

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[3] Feder, S. A. 1997. Factions and Policon: New Ways to Analyze Politics. In *Inside CIA's Private World*, edited by H. Bradford Westerfield. New Haven, CT: Yale University Press. Pp. 274–292.

[4] Bueno de Mesquita, B., E. Cope, and R. McDermott. 2001. The Expected Prospects for Peace in Northern Ireland. *International Interactions* 27(2):129–167.

[5] Bueno de Mesquita, B. 2009 (February). A Prediction for the Future of Iran. TED Conference. http://www.ted.com/talks/bruce_bueno_de_mesquita_predicts_iran_s_future.

[6] Pita, J., M. Jain, J. Marecki, F. Ordóñez, C. Portway, M. Tambe, C. Western, P. Paruchuri, and S. Kraus. 2008. Deployed Armor Protection: The Application of a Game Theoretic Model for Security at the Los Angeles International Airport. Proceedings of the 7th International Joint Conference on Autonomous Agents and Multiagent Systems: Industrial Track. http://www.aaai.org/ojs/index.php/aimagazine/article/view/2173. See also https://www.aaai.org/ojs/index.php/aimagazine/article/viewFile/2173/2067.

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