GAME ON!
STUDYING GAME THEORY AT CTY

by Sara Kay

I am an avid fan of the eBay auction site, but I have not always been successful in winning my bids. I've often wondered how I can increase my likelihood of success. Will I have a better chance of winning if I bid up to the maximum price I would be willing to pay, rather than bidding the minimum? After reading a book on various bidding strategies, I began to think more about how people decide on their bids and what factors go into the decision-making process.

This past summer, I decided to formally challenge my curiosity by enrolling in CTY's Mathematics of Competitive Behavior (MOCB) class, also known as Game Theory, at Princeton University. Upon arrival, I was delighted to discover that our textbook, *Game Theory and Strategy*, was written by Dr. Philip Straffin—my mother's math professor in college 30 years ago!

From Poker to Politics

During the first few classes we explored games that involve basic probability, such as flipping a coin and playing the lottery. We then moved on to two-player games, in which a winning strategy is key to victory. In zero-sum games, each participant's gain or loss is offset, or balanced, by the losses or gains of the other participants. Poker and rock-paper-scissors are common examples of zero-sum games.

Once we mastered these basic concepts, the instructor introduced us to the Condorcet Paradox, also known as voting paradox, which states that deciding elections by two-way races does not guarantee, for example, that if A beats B in a two-way race, and B beats C in a two-way race, that A would be able to beat C in a two-way race. This is because some voters who perhaps liked A's policies over B's might yet prefer C's policies over A's.

Rational or Irrational?

As the week progressed, we covered more complex concepts such as the Prisoners' Dilemma. In the traditional version of this game, the police have charged two people with a crime and are questioning them separately. Either can improve his situation by confessing and implicating the other one—or he can remain silent. If one confesses, the other must do the same or suffer the extra-harsh sentence that awaits a holdout. If one keeps silent, the other can obtain favorable treatment by confessing. Therefore, confession is the logical strategy for each. But if both confess, the outcome is worse for each than if both had remained silent.

Each person has a choice between two options but cannot make a good decision without knowing what the other one will do. The

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Prisoners' Dilemma shows why completely rational people might not cooperate, even if it appears that it's in their best interest to do so.

Our class simulated our own Prisoners' Dilemma where we were each randomly paired with another student and given the possibility that each of us could backstab the other. Much to our surprise, only two pairs out of a class of 15 students turned on each other! Even though our experiment didn't reflect the expected outcome, it was fun to consider the possibilities and helpful in understanding the factors that govern the balance between cooperation and competition.

During the three-week program, Sara stayed in a dorm at Princeton University.

Fluffing up Fuzzy Logic

For a team project, we were divided into groups of four to present game theory concepts. I was on a team with three students from the Czech Republic. One boy was almost a foot taller than me, so initially I felt intimidated, but he was funny and thoughtful, and eventually we became friends. In addition to collaborating with him, I managed to learn a few Czech phrases, such as "kámen, papír, nůžky!" (rock, paper, scissors!).

Our group presented on fuzzy logic, a subset of artificial intelligence. Unlike traditional logic, fuzzy logic includes a degree of uncertainty. For example, if one hypothesizes that "It will rain," traditional logic posits the statement to be either true or false. However, fuzzy logic attaches a numeric value between zero and one that represents uncertainty in a given proposition. In short, fuzzy logic measures the degree to which the proposition is accurate; hence, the proposition "It may rain" may have as its degree of accuracy 80% chance of rain.

In order to explain this concept in a creative way, we used a fuzzy avatar named "Fuzzy Wuzzy" to describe how fuzzy logic is used in home appliances such as a rice cooker. A traditional rice cooker only cooks rice one way: just flip the switch and the rice is cooked without accounting for the temperature or the kind of rice used. A rice cooker that uses fuzzy logic, however, has a "brain"—a built-in computer chip—that can distinguish between sushi rice, brown rice, or white rice and make the proper adjustment with regard to cooking time and temperature.

Power of Game Theory

Once we grasped the fundamental components of game theory, we explored such concepts as Bayes' Theorem, a version of conditional probability that is frequently used in modern machine-learning techniques. For example, spam filters use Bayes' Theorem to try to identify whether an email is authentic or spam based on the words in the email.

In our final week, we considered the current threat from North Korea based on a similar standoff between the USSR and the U.S. during the Cuban Missile Crisis. To analyze the situation, we simplified the case so each country had two options: "back down" or "proceed to nuclear confrontation." Obviously, setting off doomsday wasn't ideal for either party, leading both countries to try to negotiate a non-nuclear solution. In the end, this was clearly a zero-sum game, where one side's concessions led to the other side having more power.

This issue is very personal for me, because North Korea is now capable of launching a nuclear warhead that can reach Hawaii, where I live. Discussing the implications and complexities of the situation showed me how difficult and challenging foreign policy is. Three weeks after I returned to Hawaii, lawmakers there issued a warning to residents to prepare for a nuclear attack.

The Game of Life

Studying game theory at CTY helped me appreciate how math is related to the decision-making process and how human irrationality and emotions make that process more complex. I also learned that working as a team is more powerful and productive than working alone. The interaction among students in our class was very engaging, and consequently, I made friends from all over the world—including a girl from my birth country of Singapore.

Finally, I realized that predicting outcomes is complicated, even when it appears to be easy. As Albert Einstein said, "When the number of factors coming into play in a phenomenological complex is too large, scientific method in most cases fails. One need only think of the weather, in which case the prediction even for a few days ahead is impossible." Game on! ■

Sara Kay is a senior at Punahou School in Honolulu, HI, where she is senior editor-in-chief of the literary journal. In addition, she is editor of a digital magazine for gifted teens in Hawaii and a contributing writer to Mensa Singapore's newsletter. Sara was awarded the 2017 Alaka'i Outstanding Advocate of the Year award by the Coalition for a Tobacco-free Hawaii.