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An Uncharacteristic Application of Actuarial Science—Card Counting in Blackjack

By Michael Adams

College graduates coming into the actuarial profession usually have one goal in mind: to pass their exams and gain employment as an actuary. At this level in their career, it's expected. As with any professional, actuarial students' career goals and aspirations will shift as they grow as professionals and are exposed to different types of work. A student of actuarial science is very well-suited for these shifting career objectives due to the fact that preparation for the field involves mastery of many *transferrable* core skills.

On the preliminary exams, an actuary will learn about probability, statistics, financial mathematics, modeling mortality and other uncertain events. On the job, skills such as data analysis, model development and programming become more prominent. A professional with a strong command of these skills is well-positioned for a successful career in almost any analytical field.

The purpose of this article is to demonstrate how this array of skills can be used to analyze a complex system of uncertain events with results applicable in the real world—to some. This brings us to the casino game called blackjack.

CARD COUNTING IN BLACKJACK

Blackjack has been long-studied by statisticians due to a unique characteristic that the game possesses: being purely chalked up to chance, which sometimes varies into the player's favor depending on past cards dealt. Players who can identify intervals of the game during which they have the edge over the dealer can increase their bets to take advantage of their edge. The common term for the process players use to obtain information about the current state of the deck is "card counting."

The process of card counting involves players keeping a running "count" in their head by summing pre-determined values associated with each card that has come up on the deck. Generally, lower cards have higher associated values (+1, +2, etc.) and higher cards have lower associated values. There are numerous counting strategies with different values associated with the cards. But universally, the nature of the game is such that having more high cards left in the deck is beneficial to the player. Therefore, more lower cards coming out equates to more high cards left to be played in the deck, while a higher count indicates to the players that the deck might be in their favor.

THE MODEL

Pulling from some of the tools I learned on our preliminary exams and my extensive work experience in Microsoft Excel, I used Bayesian and conditional probability to develop a dynamic chart of optimal player moves (hit, stay, double, split, surrender) based on the player's hand and the card that the dealer is showing. The chart contains expected values for each move and is based on a set of game variants.

With this model and some assumptions, we can perform calculations to obtain a composite expected value for the game and a chart of optimal moves for a player—information that is readily available with an Internet search. However, I emphasize that this model is dynamic because it depends on the user-inputted composition of the remaining deck, which brings me to the Monte Carlo simulations.

SIMULATIONS

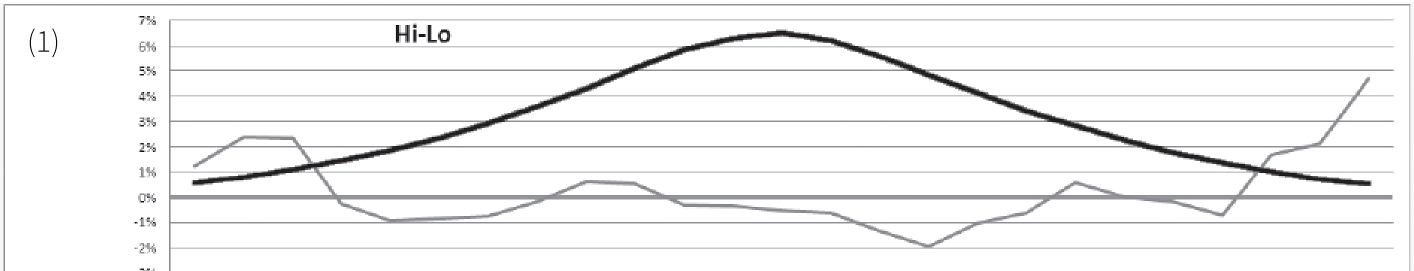
A big part of many actuarial students' training and on-the-job work is programming. A useful programming language that complements Excel work is Visual Basic for Applications (VBA). Using my work experience in various programming languages and in VBA directly, I developed a program that performs millions of blackjack game simulations, updating the deck composition after each card that comes out. This program, paired with the model described above, provides a complete picture of real-life blackjack games, which I use to model the relative effectiveness of various card-counting strategies as well as other metrics of the game.

DATA AND RESULTS

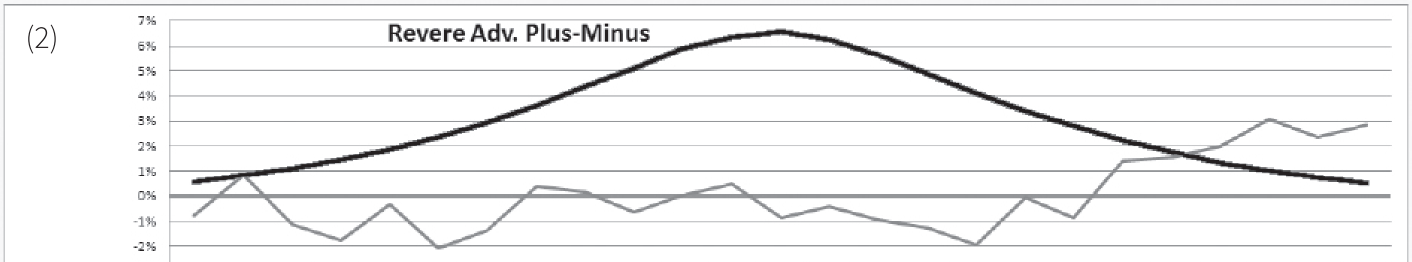
Similar to an actuarial model used in practice, the user can input various game parameters, customize the card-counting strategies, and run the model to produce a rich dataset of gameplay data that can be mined for informative game metrics and strategy performance. Using this output, players can tweak their strategies and see the quantitative impact that these changes make on their performance.

The richness of the data and customizability of the model allow the users to answer almost any question they have about the game. One useful way to visually represent the results of the trial is to plot the user's deck edge against the running count using a particular counting strategy, determined by the user. For example, here are two counting strategies: the strategy most commonly used by counters called Hi-Lo (1) and a less popular strategy called *Revere Adv. Plus-Minus* (2). While both use pre-determined values assigned to each card, the values differ between the two strategies.

In comparing these two strategies on the same simulation



	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
Player Edge	0.012	0.024	0.023	-0.003	-0.009	-0.009	-0.007	-0.002	0.006	0.005	-0.003	-0.003	-0.005	-0.006	-0.013	-0.019	-0.010	-0.006	0.006	0.000	-0.002	-0.007	0.017	0.021	0.047
Dampened Freq.	0.006	0.008	0.011	0.015	0.019	0.024	0.029	0.036	0.043	0.051	0.059	0.063	0.065	0.062	0.056	0.049	0.042	0.034	0.028	0.023	0.018	0.014	0.010	0.007	0.005



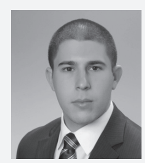
	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
Player Edge	-0.008	0.009	-0.011	-0.018	-0.003	-0.021	-0.014	0.004	0.002	-0.006	0.000	0.005	-0.009	-0.004	-0.010	-0.013	-0.019	0.000	-0.009	0.014	0.016	0.020	0.031	0.024	0.029
Dampened Freq.	0.006	0.008	0.011	0.015	0.019	0.024	0.030	0.036	0.044	0.051	0.059	0.063	0.065	0.063	0.056	0.048	0.041	0.034	0.028	0.022	0.018	0.013	0.010	0.007	0.005

run (with about half a million game simulations), you can see that they behave differently, and informed counters can adjust their betting strategy accordingly. A big part of card counting is doing so in a discreet manner. Card counting is not illegal, but many casinos that suspect you of counting will ask you to leave the casino. With this in mind, one could argue that the second strategy in our example is marginally better than the first. You can see that whereas the player's edge in (1) increases to above 0 percent sharply at count 10, the player's edge using (2) gradually increases above 0 percent starting at count 7, and stays there for a wider count interval. This enables players using (2) to gradually increase their bets to take advantage of their edge, while avoiding the casino's arousal of suspicion.

Additionally, you can see from these graphs that even with playing 500,000+ games, there is still a great deal of volatility. This arises partially from the "all-or-nothing" nature of blackjack game outcomes, and partially from the fact that card counting at its best is still only a weak indicator of player edge.

My intent with this article is not to argue that an actuary would be wise to career-change into counting cards at casinos. Rather, it is to demonstrate that the array of skills we develop in our studies and on the job enables us to conquer a very broad range of analytical pursuits, not limited to traditional actuarial work in insurance or consulting. We can apply our skills to perform complex analyses that wouldn't be possible without our thorough understanding of statistics, modeling and complex systems.

If you have any questions, comments or suggestions, please feel free to reach out to me at *michael.adams452@gmail.com*. ■



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